AUTOMATED DOCUMENT CONVERSION: A MANAGER'S PERSPECTIVE.

THESIS

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AFIT/GIR/LAS/96D-4

19970110 037

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DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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Presented to the Faculty of the School of Logistics and Acquisition Management

of the Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Information Resource Management

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December 1996

Approved for public release; distribution unlimited

Acknowledgments

As in any project of this magnitude, there are many people to whom I owe a debt of gratitude for helping me to complete this adventure. My wife (Trisha) and my children (Tiffany, Buddy, Courtney, Joshua, and Faith) were my source of inspiration to continue working when the effort was most difficult. They also endured the stress and extra efforts required to carry on a normal family life while I was immersed in this study.

My thesis advisor, Professor Dan Ferens, provided me with encouragement, understanding, and guidance when I needed it the most. His gentle prodding ensured steady (albeit slow) progress toward the goal. My reader, Capt Mike Morris, provided valuable and timely input to the process after stepping in at the last minute to help out. The value of a responsive thesis committee has proved to be tremendous in relieving the pressure associated with this project.

The experts who participated in the survey were all very helpful, both in responding to the survey and in providing valuable resources to further the study. Mr. Jay Rivest (HQ USAF/SCTA) provided the seed for the topic of this study and was helpful in identifying potential experts to participate in the survey.

Above all, I give thanks my Lord and Saviour, Jesus Christ, to whom I am forever indebted, and for whom I conduct my activities here in this sometimes challenging and confusing world.

Fredrick W. Knaak III

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Abstract

Technological advances in our workplaces have made electronic documents pervasive throughout the USAF, DoD, and civilian world. Managers are recognizing the need to establish electronic document management systems to handle these diverse forms of documents. Unfortunately, they have been faced with essentially "reinventing the wheel," when it comes to determining which types of paper-based documents are best suited to conversion to an electronic format. There is also a lack of clearly identifiable cost factors associated with automated document conversion (ADC) for managers to use when conducting an economic analysis of a potential imaging application.

This thesis addresses the problem of developing a practical solution to identify cost and mission effective ADC applications, and the primary cost factors associated with ADC, both tangible and intangible. While the researcher offers no statistically significant findings, valuable information is presented which helps managers identify ADC applications which will provide the most mission impact for their precious resources. It also provides an understanding of the tangible and intangible benefits of an ADC project, as identified by experts in the document imaging field. Additional "lessons learned" are related by the experts which provides information valuable to managers considering this technology for solving their own business problems.

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I. Introduction

Background

The Government Performance and Results Act (GPRA) of 1993 required government managers at all levels to rethink the way they conduct their various business functions. The "do more with less" atmosphere in which all government employees now function is driving them to find innovative ways to carry out this edict. In the area of information resource management (IRM), the utilization of automated information systems (AIS), electronic records management systems, and workflow management systems is becoming vital to the effective management of the government's most precious resource—its information.

The current process of managing information within the Department of Defense (DoD) has been virtually unchanged for decades. There is a nearly total reliance on manual processes designed to handle paper-based records. This paper-based system does not adequately address the requirement levied upon DoD managers to manage the numerous electronic documents created during the daily operations of the DoD. Additionally, the paper-based records management system does not take advantage of any of the benefits of an electronic records management system (i.e. improved accessibility of records, reduced storage costs, and improved document service to users.

In April of 1995, the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence/Information Management (ASD/C3I)

published the Automated Document Conversion Master Plan (ADCMP). This document provides DoD managers with strategic guidance regarding the acquisition and implementation of automated document conversion (ADC) hardware and software. The ADCMP is founded upon laws and regulations which govern both records management and acquisition within the DoD. The vision statement below provided the guidance for the authors of the ADCMP:

> DoD Automated Document Conversion efforts will strive to convert documents to standards-based formats that allow users, with differing functional requirements, to share the contents of documents and perform conversion based on a cost-justified business case, applying Corporate Information Management (CIM) principles and DoD policies and procedures. (OASD, 1995)

It further states that "Military mission and business requirements, and a business case that clearly articulates the functional and economic benefits anticipated from conversion, will guide conversion decisions." (OASD, 1995) In order for DoD managers at all levels to make cost effective and mission oriented ADC decisions, a method must be developed to accurately determine appropriate activities for ADC. This method must consider not only the costs of ADC, but more importantly the mission impact of the particular ADC project.

The first step in the ADC process identified in the ADCMP is to determine whether a strong business case exists to support ADC. A fairly comprehensive Business Case Decision Table (BCDT) (Table 1) has been developed by the DoD to assist managers in determining whether an application is appropriate for conversion (OASD, 1995). While this table provides a good structure for managers to use in development of the business case, it lacks the details necessary to actually develop the business case.

Table 1. Business Case Decision Table (OASD, 1995)

Requirements Determination

• Is there a legitimate mission or business need?
• Will Records Management requirements be satisfied?
  • Are the records scheduled per NARA requirements?
  • Are NARA archival requirements satisfied?

Cost Justification
• Can the information contained in the documents be obtained from another source in a cost-effective manner? • Will automated document conversion reduce costs? • Has a comparison been made of purchase vs. Contracting the automated document conversion service? • Should centralized DoD conversion services be considered?
Document Candidate Selection
• Are the documents active and do they have sufficient volume? • Are the documents available to multiple users? • Do the documents contain valuable and relevant information? • Do the documents have a relatively long active life remaining? • Are the input/information processing routines stable? • Can the original documents be destroyed after conversion?
Technical Capability
Architecture • Does the selected architecture support the minimum functionality, ensuring the interoperability of the converted documents? Standards • Are relevant standards identified to ensure interoperability of the converted documents?

The potential gains in operational efficiency by ensuring the right information gets to the right place in a timely manner can be significant. There are a myriad of information systems being suggested by various agencies which propose dramatic savings in time, cost, and effort. A significant challenge facing managers at all levels of both civilian and government organizations is how to effectively and efficiently apply information resources to their operational problems. Automated information systems

(AIS) which emphasize organization-wide integrated access to corporate information are becoming the focus of information resource management (IRM) professionals in civilian and government organizations. Often these systems are reliant upon electronic records management systems which can manage all types of information an organization may generate (e.g. documents, images, video, or sound.)

One of the problems encountered in converting to an information system of this type is how to manage legacy paper-based files. Additionally, when an organization converts to an automated system, it is likely that there will still be a need to manage internally and externally generated paper-based records received from organizations not yet or not likely to become electronically compatible. The conversion and indexing process which is required to effectively utilize the electronic information is manpower-intensive and costly. Converting all paper records to an electronic format is cost prohibitive. Consequently, there is a need for a method to determine the cost effectiveness of converting these paper-based records to an electronic format.

The ADCMP provides some structure for DoD managers to operate within, but lacks specific guidance on how to actually perform the various activities identified in the Business Case Decision Table (Requirements Determination, Cost Justification, Document Candidate Selection, and Technical Capability.) Currently each manager considering a particular application or group of records for ADC is essentially "reinventing the wheel" when it comes to document conversion determination. None of the lessons learned by others involved in imaging projects have been gathered and published for use by managers considering the imaging solution for document management.

Importance of Research

The results of this research should provide managers with the information necessary to determine which documents and activities are most suited for ADC. This information should also provide them with some key cost/benefit information for the financial analysts in their organization, thereby helping to ensure successful funding of the project. Identifying the critical cost factors in an ADC project can help ensure the resources of the organization are focused on those projects which will best support the strategic information goals of the organization.

Problem Statement

The requirement to effectively utilize scarce resources in an organization dictates that managers in general, and IRM professionals in particular, need a valid, efficient method to determine the cost effectiveness of ADC activities. Within the DoD, proper application of the ADCMP can facilitate this process. While the ADCMP provides a general framework for this process, it lacks specific details to carry out the process. To that end, this thesis will address the problem of developing a practical solution to identify appropriate ADC activities/processes which will provide the greatest mission impact. It will also identify the primary cost factors managers should consider when attempting to determine which ADC activities/processes are most cost effective and likely to provide the highest return on the organization's investment.

Research Objectives

The objectives of this study were to determine the primary cost factors useful for managers to determine cost effective ADC activities. In order to determine if ADC will reduce costs and/or increase operational effectiveness, analysis was needed to identify the

costs associated with an electronic approach to document management. In recognition of the often non-quantifiable benefits of document conversion this thesis also attempted to identify the primary factors, both tangible and intangible, which will help managers prioritize ADC projects.

Research Questions

In order to answer the research problem identified previously, this study addressed the following research questions:

1. What are the primary cost factors involved in an ADC project, both tangible and intangible?
2. What are the major benefits reaped by an effective document conversion project?
3. Which activities/processes are best suited to ADC with regard to return-on-investment and mission effectiveness?

The answers to these questions should provide managers with the information necessary to determine which documents and activities are most suited for ADC. This information should also provide them with the cost/benefit information for the financial analysts in their organization, thereby helping to ensure appropriate funding for ADC projects.

II. Literature Review

This chapter provides a description of the basic aspects of the ADC process. It then covers some of the document imaging hardware and software to help give the reader an overview of a typical imaging system. Some of the cost considerations of imaging hardware are covered to identify the significant drop in prices seen in the past few years and the impact this may have on the cost effectiveness of imaging projects. And finally, a review of the USAF functional economic analysis (FEA) methodology is covered, providing the reader with an overview of the method required by the USAF in order to obtain funding for a document imaging project. A glossary of terms used throughout this thesis is included in Appendix A of this document. The definitions are used verbatim from the source indicated unless otherwise noted.

Basic Imaging

One purpose of this study was to determine appropriate applications of imaging technology. Therefore, a highly technical understanding of the subject is not necessary. The following discussion of document imaging will attempt to orient the reader with basic imaging concepts.

Document imaging is the process of automatically or manually scanning a paper document through a page-scanner thereby producing an electronic "picture" of the document which is understandable by a computer. Guenette identifies the process as consisting of the following activities: Document preparation, scanning, compression, quality check, indexing, and sometimes document reassembly (Guenette, 1996:34). Electronic documents can then be managed electronically by software designed for sharing the information with other users, or performing the functions of a records

management system. The documents can be retrieved, printed, and shared by potentially numerous users at their own convenience. The electronic documents can be retrieved by users based upon the indexing scheme of the system. Common indexed fields are: document title, date, author, or other key fields (Guenette, 1996:34). Full text searches are possible if the documents are initially scanned using an optical character reader (OCR) to scan the document. This provides users with the ability to find any portion of any document which contains the particular search words entered by the user. This method of imaging is the most manpower intensive, and also the most expensive due to the manual error detection and correction necessary for accurate document capture.

Once the document has been captured electronically, provisions must be made to store the document for future use. Several methods are available for mass storage of the document images including: Rewritable magneto-optical (MO) disk, WORM (write once read many), and CD-ROM. All optical disk technologies use binary digital coding to record the information on a disk of some type using a laser light beam to record and read the information (Avedon, 1994b:34.) WORM is a technology which enables the user to record an image on the media and then read that image without allowing any modification of the image after creation. It is suitable for applications which require source document integrity. WORM disks come in a variety of sizes and capacities as indicated by the following table.

Table 2. WORM Disk Capacity (Avedon, 1994b:35)

- 200 dots per inch (pixels)
- 8-1/2 x 11 inch pages
- Black & White documents
- Two-sided disks

Disk Size (in inches)	Capacity in MB	Capacity in GB	Capacity in Pages 10:1 Compression Ratio	Capacity in Pages 15:1 Compression Ratio
5-1/4	**1000**	**1.00**	**20,000**	**30,000**
12	**10,200**	**10.20**	**220,000**	**330,000**
14	**10,200**	**10.20**	**220,000**	**330,000**

Rewritable MO disks are very similar to WORM but the allow the user to modify the image once it has been initially created. This technology is suitable for documents which need to evolve during their lifetime, such as engineering drawings, legal documents, or collaborative documents. The following table identifies some of the characteristics of MO disks:

Table 3. Rewritable Magneto-Optical Disk Capacity (Avedon, 1994b:35)

- 200 dots per inch (pixels)
- 8-1/2 x 11 inch pages
- Black & White documents
- Two-sided disks

Disk Size (in inches)	Capacity in MB	Capacity in GB	Capacity in Pages 10:1 Compression Ratio	Capacity in Pages 15:1 Compression Ratio
3-1/2	**256**	**.26**	**5,000**	**7,500**
5-1/4	**2,000**	**2.00**	**40,000**	**60,000**

CD-ROM disks have a capacity of 650 Mb with a price under $1,000. CD-Recordable (CD-R) drives are becoming a cost effective solution to archiving large collections of image files. CD-ROM is the lowest cost of any randomly accessible optical media available today (Brach, 1996:50.) A new form of CD-ROM known as digital versatile disk (DVD) will soon be commercially available which allows up to 9 Gb of storage on one disk. The CD-ROM is a truly universal storage medium in that it can be used on any CD-ROM drive for use on a computer. This versatility makes it extremely suitable for data exchange between potentially different imaging systems. CD-ROM jukeboxes can enable a system to store hundreds of CD-ROM's online for reasonably quick access by system users. A drawback of CD-ROM is the high overhead usage of storage space when files are written to the CD-R in different sessions. This can effectively waste up to 20 percent of the storage capacity of the disk. CD-ROM drives are also slower to access the records than other optical media. Figure 1 illustrates a cost comparison of various storage media compiled by Lucarini in January of 1996.

Online access to documents is often accomplished via existing Local Area Networks. This storage scheme allows access to the digitized images by any PC connected to the network and facilitates multiple users of the documents. Distributed document management software enables users to store their images on their local hard drives, while still allowing other users access to the files.

Users can view documents using their existing PC resources. The typical 14" or 15" PC monitor is acceptable for occasional imaging users. Some monitors swivel in order to accommodate a page-oriented view. For heavy imaging use a more appropriate monitor size will be from 19" to 21" with minimum resolution of 1024 by 1280 pixels.

When selecting an appropriate monitor, consider things such as size, resolution, display mode (horizontal/vertical), multiple page display, ergonomics, and price (Avedon, 1995b:24).

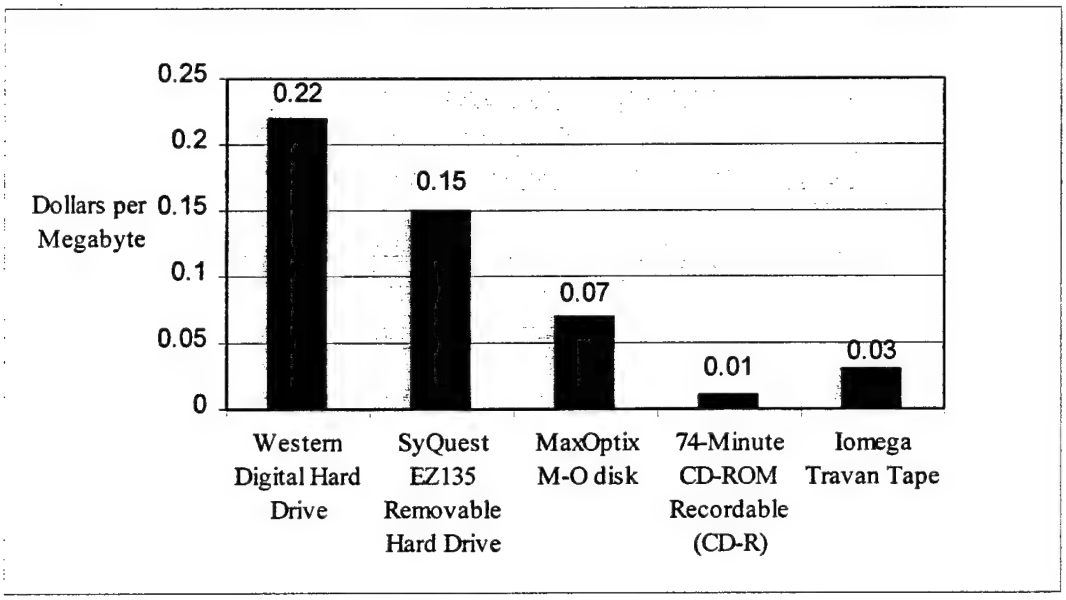

Figure 1. Price of Competing Media (Lucarini, 1996:60)

Several technology developments have enabled the increased usage of electronic methods of document handling which include digital image processing, large capacity storage, hypertext, multimedia documents, high bandwidth communication channels, electronic printing, electronic mail and fax, and improved techniques for information and text retrieval (Sprague, 1995:36).

"Electronic image management includes systems comprised of technologies, procedures, and methods for automated processing of paper documents and microfilm documents. The information on the documents may be handwritten, typewritten, computer printed, text, numbers, or graphics in any combination and in any format (Langemo, 1993:4)."

This definition covers a myriad of communication forms being introduced into our daily office communications, beyond the traditional paper or electronic document. An effective imaging solution should be farsighted enough to encompass not only present, but also future changes in our environment. A more comprehensive definition of a document is proposed by Michalski (1996:61) "A document is a snapshot of some set of information that can:

- Incorporate many complex information types;

- Exist in multiple places across a network;

- Depend on other documents for information;

- Change on the fly (as subordinate documents are updated);

- Have an intricate structure, or complex data types such as full-motion video and voice annotations;

- Be accessed and modified by many people simultaneously (if they have permission to do so)."

His definition encompasses the new version of "documents" we are using in media such as the World Wide Web or Internet. For the sake of future expansion and flexibility, it is necessary to keep a large view of information when we implement image management systems. However, this comprehensive view exceeds the scope required for this study. The primary focus of this study remains the paper document commonly used throughout most organizations; more specifically, the conversion of paper documents to an electronic format for use within an organization's overall document management system infrastructure.

For readers interested in a more technical view of document imaging Avedon's series "Imaging 101" is quite thorough. Additionally, the National Archives and Records Administration published a comprehensive report covering document imaging in March of 1991, entitled "Optical Digital Image Storage System: Project Report." This study is a tremendous asset for any manager or IRM professional considering an imaging application. Appendix A of this report is a comprehensive description of digital image and optical media technologies. Review of this document in its entirety is highly recommended.

Decreasing Imaging Costs

Since the time of this report's publication, the price of imaging hardware and software has dropped drastically. The versatility and power of the desktop personal computer (PC) has increased significantly as well. These significant changes in the field of document imaging have necessitated a new look at the cost/benefit considerations of this technology. The field of document imaging and ADC is changing rapidly. It is likely that cost information compiled even as little as two years ago could lead to ineffective management decisions today.

A good example of the speed with which the field is changing can be found in the prices for imaging hardware. Figure 2 identifies the cost curve of Compact Disc-Recordable (CD-R) drives as published in CD-ROM Professional, a prime publication of the imaging industry.

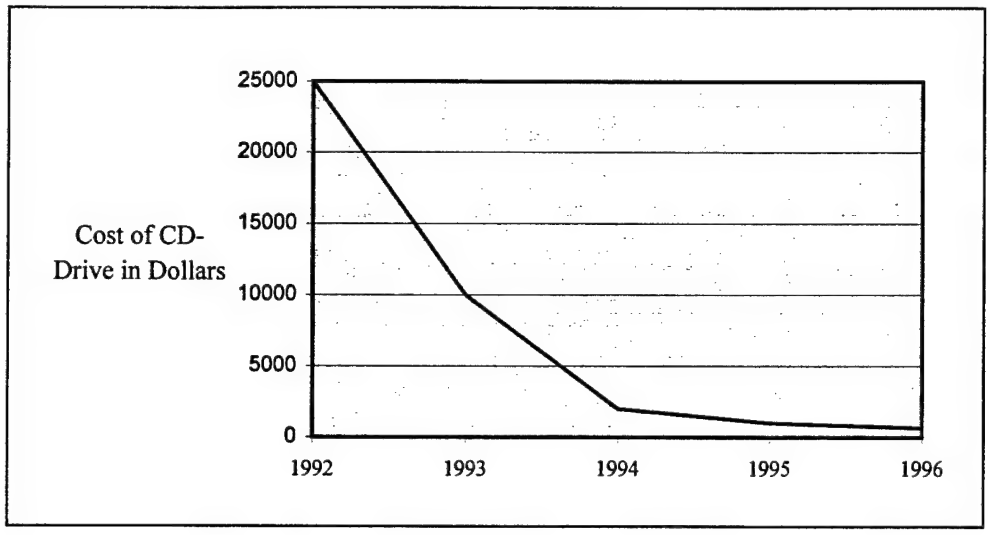

Figure 2. Decreasing Price CD-R Drives

As we can see, in 1992 a manager considering CD-R as a storage solution for a document imaging project may have been deterred by its introductory price of over $25,000 per drive. By the time of this study (Fall of 1996) the price for CD-R drives has dropped to the sub $1000 range and CD-R blanks are in the $7 - $9 price range (Brown, 1996:152). CD-R drive affordability has overcome one of the major cost challenges facing managers who desired to convert their document management system to an all electronic operation--the problem of mass storage. Within one to two years Digital Video Disk CD's will be available commercially which can store over 8 gigabytes (Brach, 1996:50). This will once again require us to rethink our document storage strategies. With the cost economies presented by CD-R technology, the hurdle of providing a cost effective method of storing the large image files is now being overcome.

Similar cases can be made for magnetic hard drives, page scanners, powerful PC's, and image management software. The prices for these key components of an imaging solution are undergoing a rapid decrease like those of CD-R drives. This

significant drop in prices may make an application cost effective today that just a few years ago would have been cost prohibitive. The astute information resource manager will constantly be scanning the marketplace to determine when an application is economically feasible, based upon predetermined analysis of the scope of the imaging project.

Backfile Conversion

When considering a particular application or activity for conversion to an automated process, we are faced with the task of converting legacy files or documents to the new electronic format. Due to the significant costs involved in backfile conversion, it is essential that any document conversion project accurately determine candidate legacy documents for conversion. Blanket conversion of all documents in an organization would be extremely cost-prohibitive. Essentially there are three basic strategies for backfile conversion—from-this-day-forward, convert-the-backfile, and scan-on-demand (Avedon,1994b:38.) From-this-day-forward means only documents received as of the installation of the imaging system are scanned into the system. No legacy files are scanned and the old manual system would be operated until the documents in it are retired. Converting-the-backfile is the most costly option because all legacy documents are scanned initially. This solution is appropriate when the documents are very active and still used on a regular basis for daily business transactions. The third strategy Avedon identifies is scan-on-demand. This method scans documents as they are requested by the users. No backfiles are initially scanned, but as a need for a document becomes identified it is then converted to an electronic format.

Avedon (1994b:38) identified seven major tasks of backfile conversion:

- Document preparation
- Scanning
- Inspection for quality
- Indexing into locatable subject areas or references
- Image compression
- Media recording
- Quality assurance and integration

The backfile could be a few hundred documents going back a few months or perhaps several million pages of permanent records going back 50 or 60 years. The retention schedule, reference rate, urgency of reference, quantity of material, and operating system should all be considered when determining whether, or how much of, the backfile should be included in the new system.

Functional Economic Analysis

The DoD has developed a process which can be used to determine the economic viability of various business process improvement activities. This methodology is called Functional Process Improvement (FPI). Essentially, FPI is a method which identifies business activities within an organization for improvement and then uses a structured approach to identify, evaluate, and implement improvements to DoD processes (DoD,1993:). FPI is part of the government mandate to develop and implement strategic plans and to ensure that any new information systems implemented directly support those strategic plans.

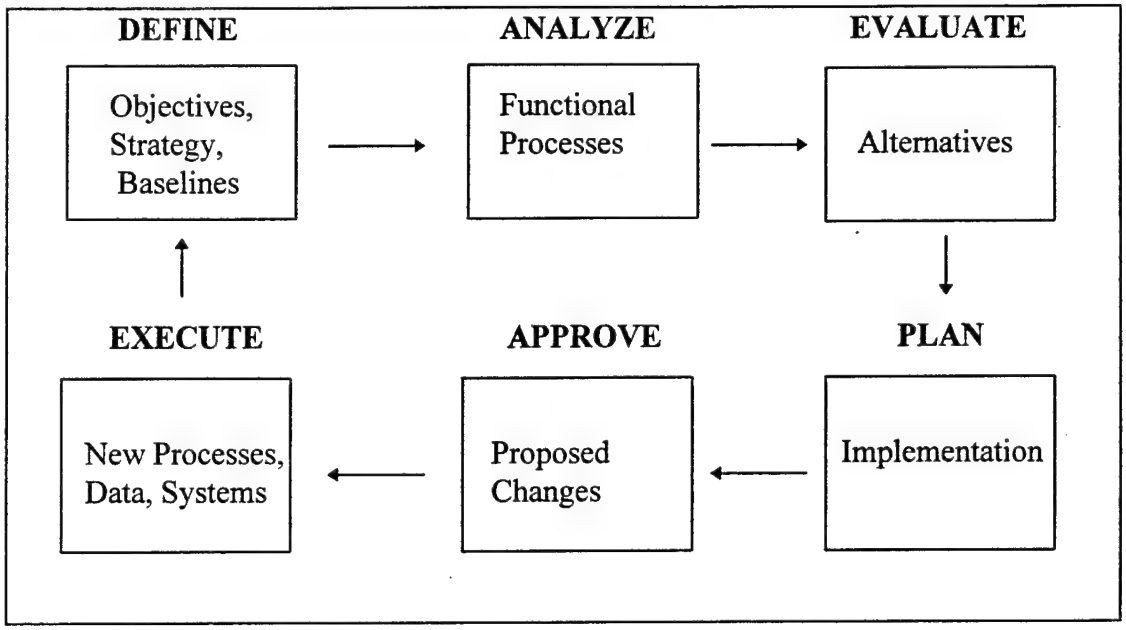

Figure 3. Functional Process Improvement Cycle (DoD:1993)

One of the major parts of FPI is a process known as Functional Economic Analysis (FEA). The FEA Guidebook is a step-by-step document which helps managers carry out the mandated FPI process of FEA. The guidebook provides examples and guidance which can help managers perform the difficult task of identifying worthwhile projects to improve their function. Since this document is readily available, a discussion of the basic concepts involved in performing an FEA will be provided here.

FEA is a part of the FPI methodology which applies a structured methodology to identify the baseline costs of an activity or process, and then determine the potential costs of an improved process. FEA provides operational managers with the information needed to determine the best alternative activity identified during the FPI (DoD:1993). The FEA is also used during the approval phase of FPI to provide Congress with the information it needs to determine whether to fund a particular project (DoD:1993). FEA is required for any new information systems acquired in the DoD.

Three general principles guided development of the FEA methodology. First, it was developed with a functional focus, concentrating on evaluating changes to functional processes instead of information systems. It was designed to provide managers with "bottom-line" information which can be used to utilize all resources within the DoD effectively. With regard to information systems, FEA ensures the acquisitions are directly in support of strategic goals of the DoD, not just because of technological considerations (DoD:1993).

The second principle which guided development of the FEA is that it requires measurement of the major parts of functional processes. These attributes are the major parts that make up an activity like costs of resources used in the process. These quantitative measures are used by managers to assess the current state of a function, and to evaluate alternative methods for achieving the goals of the function. They also provide them with the ability to gauge progress towards those objectives (DoD:1993).

The last guiding principle of the FEA methodology is that it should provide managers with an ongoing tool with which they can effectively manage their function. It is designed to give managers the information needed to respond to programming and budgeting exercises. The FEA provides management information which is needed to track progress of the function towards goals identified in the FPI process (DoD:1993).

FEA is involved in the Evaluate and Approve steps of the FPI cycle. In the Evaluate step, FEA is used to help managers determine which alternative processes should be chosen to improve the overall function. It provides managers with quantitative, structured information and allows educated decision making. The FEA information is also used to help get approval for the alternative chosen in the Evaluate step. Information

from the FEA is used during the acquisition process to identify requirements and funding needs to Congress. The more accurate and complete the FEA, the more likely the project will be approved and funded.

Summary

Research has been conducted by both US government and academic institutions as to potential imaging applications. While fairly comprehensive, this research bases its conclusions on imaging solutions which fail to consider the advances in hardware capability and costs recently achieved. These studies provide us with a framework for identifying some of the cost considerations of ADC projects. They also identify some potential document imaging applications. The costs of document imaging hardware and software have dropped so rapidly in the past few years. The information potentially being using to determine cost-effective imaging applications may be outdated and possibly inaccurate. Additionally, while an outline exists for ADC, the specific cost factors which contribute the most to effective cost/benefit analysis of ADC decisions are not clearly identified in the literature. Effective management-oriented imaging solutions need to be identified to ensure proper focus of information resources toward mission accomplishment.

III. Methodology

Overview

The purpose of this chapter is to describe the methodology used in this study to answer the research questions posed in chapter 1. A brief summary of the problem is presented and is followed by the methodology, description, and justification of how the specific research questions were answered.

There is little current academic literature regarding the costs and benefits of document imaging and specifically about ADC. The primary source of information of this type tends to be found in sales literature from organizations involved in the document management or imaging business or in commercially oriented trade publications. While it is possible that the cost/benefit factors identified by these commercial organizations are accurate and factual, there exists the probability that this information is skewed to ensure their product or service is represented in a favorable manner.

This research sought information which was less likely to be biased than that often found in commercial literature. Therefore, a literature review was conducted which concentrated on identifying cost factors related to ADC. The literature review also looked for benefits identified, both tangible and intangible. And finally, the literature looked for activities and processes which were recommended for ADC.

Upon completion of the literature review, the information was integrated into a questionnaire which was designed to attempt to identify the accuracy and currency of the information identified in the literature. This questionnaire was given to experts in the document imaging field. The results of the questionnaire were then analyzed and consolidated with the results of the literature review into a composite group of costs and

benefits of document imaging and activities and processes identified for document imaging. A copy of the questionnaire can be found in Appendix B and is described further below.

Problem Summary

In order for managers to determine which projects or activities are best suited for automated document conversion, the following research questions were addressed:

1. What are the primary cost factors involved in an ADC project, both tangible and intangible?
2. What are the major benefits reaped by an effective document conversion project?
3. Which activities/processes are best suited to ADC with regards to return-on-investment, and mission effectiveness?

It is believed that accurate answers to the research questions stated above will provide us with the insight necessary to make effective management decisions about ADC and related document imaging problems.

Research Methodology

The goal of this research was to determine cost factors and benefits of document imaging and potential applications for ADC. Since this area has undergone such rapid technological change, the literature relating to this subject is either outdated or of a commercial sales-brochure type. This study's qualitative and exploratory nature lent itself to a mixed methodology of document analysis/expert interview. Each of these will be described in detail in the sections which follow. Cooper and Emory identify qualitative research as being performed through several approaches, two of which are

interviewing and case studies. It was determined that this approach would provide the initial identification of the cost factors involved in ADC. It also allowed the experts in the field to provide their insight and expertise to development of the final product—the recommendations for other managers considering ADC projects.

Document Analysis

Document analysis was initially used to develop the survey questionnaire as explained previously. It was believed this process would produce a survey which would reflect the authors' views of key ADC cost factors and applications. After the results of the survey were compiled, document analysis was again performed with the focus on extracting information which supported or refuted information produced by the survey. This second pass at the documents was intended to identify information previously overlooked or not included during survey compilation.

Survey Instrument

The survey questionnaire, shown in Appendix B, consisted of three parts. Part I is a section which identifies the respondents' background and establishes the level of expertise the person feels they have about document imaging. This section is used to screen out survey participants who might not have the appropriate knowledge level necessary for the survey. Part II consists of the actual questions used in the questionnaire. There are two types of questions, the first 17 are statements about document imaging relating to cost considerations and benefits which have been proposed in the literature. The questions are answered by checking appropriate boxes in a Likert scale to indicate the respondent's level of agreement or disagreement with the statement.

The second group of questions were open-ended, opinion-oriented questions. They queried the experts as to their own opinions about the benefits, potential economic considerations, and activities which would be successful for ADC. The questions attempted to solicit the experts' advice in a manner which would produce recommendations for other managers who are considering an ADC project.

Identifying the Experts

The questionnaire was used to query experts in the field of document imaging to determine if the information identified in the literature was valid and appropriate. The instrument also sought to identify the experts' views about the primary considerations a manager should address when identifying cost and mission effective imaging applications. They were asked for their responses to questions relating to document imaging, ADC, and the activities they believe would best lend themselves to ADC.

The experts are individuals who have experience with implementing or approving imaging systems and have several years of experience in the field. They were identified by contacting the HQ USAF records management office and requesting the names and phone numbers of individuals in the DoD who were currently or previously involved in document imaging projects. This produced a list of approximately seven individuals. Several of these individuals agreed to participate in the survey. They also identified other potential experts in the field who would prove useful to the research. Further search produced individuals in the history offices of major commands who have experience with using document imaging for archival purposes.

In order to provide a broad range of experts, several commercial organizations with document imaging experience were also contacted. Some of these were service

bureau organizations which provide imaging services to other companies and others were organizations which provide consulting in the imaging field.

The experts were given the assurance that the information they provided would be consolidated with that of other experts in the field and their anonymity would be maintained. It was felt this would allow them to be more free with their responses without fear of retribution from their perspective organizations if their opinions were not in line with the organizational dogma.

After the data collection phase of the study, the information gathered was then consolidated into findings which should prove useful to managers who are considering document imaging or ADC for improving processes within their functional area.

Justification of Research Methodology

Marshall and Rossman (1989:46) identify several types of studies which lend themselves toward qualitative research methodology; one of these being research for which relevant variables have yet to be identified. Due to the paucity of information available identifying cost factors of document imaging, it was believed that this study was a candidate for qualitative versus quantitative methodology. Had there been previously identified cost factors available in the literature, a quantitative study may have been more appropriate in order to determine the validity and importance of these factors.

The research questions proposed in this study centered around identifying the processes and activities best suited to ADC and the cost factors involved in those activities. Marshall and Rossman (1989:Table 3.3) propose in-depth interviewing or elite interviewing as methodologies which would help solve a problem which is exploratory, trying to identify important variables. Due to the resource constraints of this study, in-

depth interviewing was deemed to be unfeasible and a method similar to elite interviewing was conducted.

Elite interviewing consists of selecting the experts based upon their expertise in the areas relevant to the research being conducted (Marshall and Rossman, 1989:94). One of the drawbacks to elite interviews is the difficulty in reaching and obtaining time of the experts. By developing a questionnaire through document analysis of the literature available on this subject, identifying experts in the field of document imaging, and then using the questionnaire to "interview" them, it was hoped that this would produce similar results to in-depth, elite interviews. The time required of the interviewees would be minimized, and place less of a burden upon participants in the study. It was expected that the experts would be able to validate or invalidate the information identified through the document analysis.

Several advantages are identified by Kervin (1992:421) when using questionnaire surveys for qualitative research: Low cost of administration and personnel, anonymous setting for potentially threatening or embarrassing questions, and it is easier to ask for information which requires respondents to take time to gather.

A combination of data collection techniques is not uncommon in academic research (Marshall and Rossman, 1989:101). By combining the different techniques, the strengths of each can be used to help strengthen the research. The goal of the combination of methods in this study was to provide a range of sources for data collection to better support its external validity. A study which reviews several cases and uses more than one source for its information can make the study more useful for other settings (Marshall and Rossman,1989:). The particular combination of methods used in this

research were chosen to ensure a sound research foundation while conforming to the resource constraints of the researcher.

Summary

The primary methods identified in the methodology of this study were document review and a form of elite interviewing. The document review provided a source for creating a survey questionnaire which was then administered to experts in the imaging field. This method was used to minimize the time investment of the experts and to approximate an elite interview with each expert. The information gathered from the interviews was then compared with the documents used to create the survey instrument to identify any potentially overlooked cost factors or information valuable to managers considering ADC.

IV. Findings and Analysis

Overview

This chapter will provide the reader with the results of the research conducted in this thesis. It will begin with a question-by-question review of the results of each question of the survey, including the distribution of response values of the scaled-response questions and an interpretation of what the responses may indicate. I then discuss the responses to each of the open-ended questions and analyze any patterns or significant results. The chapter will close with a summary of key information extracted from the expert surveys, and how the responses either support or refute the imaging cost factors, benefits, and appropriate imaging applications identified during the document review portion of the research.

Expert Demographics

This section will review the demographic responses of the experts who participated in the survey. The section of the survey which provided this information was Part I. The purpose of Part I was to identify any individuals who were not adequately familiar with document imaging, thus potentially invalidating the results of their survey responses. Due to the pre-survey telephone conversations with the experts, the probability of having a knowledgeable individual was fairly high. The first section of this chapter is designed to establish the credibility of the experts' responses for the readers of the study since they were not a part of the telephone screening process.

A total of 13 surveys were sent to individuals who agreed to participate in the survey. Due to time constraints, only eight responses were received. One of these was from an individual who has very little experience in the imaging field and was therefore

deleted from the results discussed later in this chapter. Although this individual was not identified as an expert, she was able to provide some interesting insight from a user perspective which will be noted in the results later in this chapter. Responses by the disqualified individual were noted in the following section with an asterisk. The questions and response distributions for Part I of the survey are as follows:

1. **What is your current level of knowledge about document imaging systems and applications?**

☐ None ☐ Minimal ☐ Average ☐ Above Average ☐ Expert

Responses:	0	1*	2	6	0

Nearly all respondents indicated above average knowledge of document imaging. This is desirable since the goal was to identify experts. The asterisked response is the only individual who was not contacted telephonically prior to being surveyed and probably lacks the knowledge necessary to be considered an expert. This individual's responses will be noted with an asterisk throughout the rest of the analysis.

2. **What is your current level of knowledge about information systems/technology?**

☐ None ☐ Minimal ☐ Average ☐ Above Average ☐ Expert

Responses:	0	1	2*	6	0

Responses were nearly identical to previous question. Again, supporting the goal of identifying expertise in the field. It is not known why one individual rated his/her experience level as minimal. I would assume this is because the individual was not an IS professional, he was a Director of Historical Services. While information systems

knowledge was rated high by most of the experts, our major desire was to have a strong background in document imaging technology. A self-identified minimal knowledge level in information systems does not invalidate this individual's imaging knowledge level.

3. **What is your current organizational tier?**

☐ Technician ☐ Tech/Supervisor ☐ Mid-Level Mgr ☐ Senior Mgr

Responses: 2 1 5* 1

This question helps identify the level in the organization the experts are currently filling. The mid-level managers should have both an understanding of the technology used in their sections, and a manager's understanding of the costs associated with obtaining and using the technology. The technicians provide us with a more detailed knowledge of the application of the technology to the work processes. This range of viewpoints was reflected in the types of open-ended responses the experts gave.

4. **What type of organization are you currently working for?**

☐ Gov. Civilian ☐ Gov. Contractor ☐ Military ☐ Commercial

Responses: 7* 0 1 1

The majority of the respondents were government employees. It was desired that the experts should reflect a variety of backgrounds but time constraints precluded obtaining a wider range of experts.

Note: This question mislead some of the respondents. It was intended to determine whether the individual was a government civilian, government contractor,

military, or worked for a commercial organization not affiliated with the government. The responses of individuals who were mislead by the wording of the question were adjusted to reflect the intended meaning of the question.

5. **What is your current job title?** _____

The job titles of the experts were as follows: Historian, Joint Staff; Senior Consultant; Systems Analyst; Chief, Information Management; Historian; Director of Historical Services; Chief of Information Systems Division; Staff Historian; and Management Analyst. Again, this reflects a broad range of occupations and levels of management/technical experience.

6. **How many years of experience do you have with document imaging systems or applications?**

☐		Less than 6 months
☐	1*	At least 6 months but less than 1 year
☐		At least 1 year but less than 2 years
☐		At least 2 years but less than 3 years
☐	3	At least 3 years but less than 4 years
☐	5	4 years or more

The experience level of the experts was nearly all above 3 years, with more than half above 4 years. This strengthens their expert standing. Due to the quick-changing nature of the imaging field, 3 or more years should be adequate to develop a strong understanding of current imaging technology and its application.

7. **Please describe your experience as it relates to the area of document imaging technology or systems. For example: "I led the design and implementation of a**

major imaging system at the organization-wide level. It consisted of over 30 imaging stations and 5 million dollars worth of equipment."

The following statements are taken directly from the questionnaires, but information which might identify the individual has been modified to maintain anonymity of our respondents:

"I wrote the original Air Force specification for a document imaging system consistent with the National Archives and Records Administration's electronic record-keeping directive. Eventually, I became the senior technical advisor for electronic record-keeping in the Information Management Research and Development Branch. This was a position with dual responsibilities under the joint Air Force-Wang Corporation development of document librarian. Additionally, I conducted the worldwide research study into information management wartime and emergency operational needs. This project dealt heavily with the electronic record-keeping and document imaging needs in the emergency and wartime requirements."

"Analyzed the business impact of document imaging in the Air Force Reserve Records Management Program and evaluated the applicability of document imaging as part of the DoD Records Management Working Group in 1994."

* "Oversaw purchase and installation of document imaging system for single office, consisting of two imaging stations (one classified, one unclassified)."

"I had to find a way to store approximately 200,000 pages of historical documents concerning a major regional conflict. I developed a plan to purchase a document scanning system, devised a process to index and store the documents, and helped prepare the indices and scan in the documents."

"My experience has been primarily in defining the requirements and preparing the program documentation and obtaining funding support for a document imaging and electronic records management system. I am responsible for defining and implementing a full-text, digital archive for the Air Force History Program. The plan is to convert existing paper and microfilm documents (approximately 65 million pages) to electronic image and text files to allow local and remote users to view the full text of historically significant documents. Once implemented, the system will also support the publishing of unit histories and other historical documents in electronic form, reducing the need to produce paper copies and significantly improving access to historically valuable information. My experience includes surveying current document imaging system installations within the public and private sectors, keeping abreast of advances in technology, and surveying the marketplace for appropriate solutions. In addition, I defined the technical

requirements for an imaging project which is being used to convert 2.5 million pages of Air Force operational documents to electronic form."

"I am the HQ focal point. I advise my supervisor, the Command Records Manager, of recommended imaging policy and procedures and review document imaging system proposals for his approval. We oversee approximately 25 systems/service requests. Our systems use various media, primarily optical, micrographics, and computer output to microfilm..."

"I led the effort to select, procure, and implement use of stand-alone document imaging system within the history office."

"I led the procurement and installation effort to install a document imaging system at to scan operational documents from a major regional conflict. It consisted, at that time, of 3 imaging stations and about $250,000 worth of equipment."

Due to the qualitative nature of this study it was felt that establishing the credentials of the experts was necessary to ensure adequate validity of the study's findings. The range of experience of the experts is quite diverse and should provide the reader with reasonable assurance that the information these individuals provide throughout the rest of their surveys is based upon solid experience in the document imaging field.

Survey Scaled-Response Questions Analysis

This section examines the responses of each scaled-response survey question and extracts any significant findings which will be able to support, refute, or weaken information identified during the document review portion of this study. Each question will be repeated, and then the reader will be provided with the breakdown of the experts' responses to the Likert scale.

Two methods were used to determine whether the experts agreed or disagreed with a particular statement. The first method was to combine the number of strongly agree/agree and strongly disagree/disagree responses for each question and divide the

sum by the total number of responses for that particular question. This gave us an agreement or disagreement percentage as appropriate. For this study, a sixty percent agree or disagree rating constituted consensus by respondents. The rationale for this rating is that with five choices on the Likert scale, each choice would be twenty percent of the range. The top or bottom forty percent would indicate a threshold which signifies the group score as either being in the "agree" or "disagree" range. Since this study is qualitative and not statistically oriented, it was felt that this would give the readers an indication of the group's consensus on a particular statement. The results of this analysis are found in Figures 4 and 5. Figure 4 pertains to agreement by the experts and Figure 5 refers to disagreement.

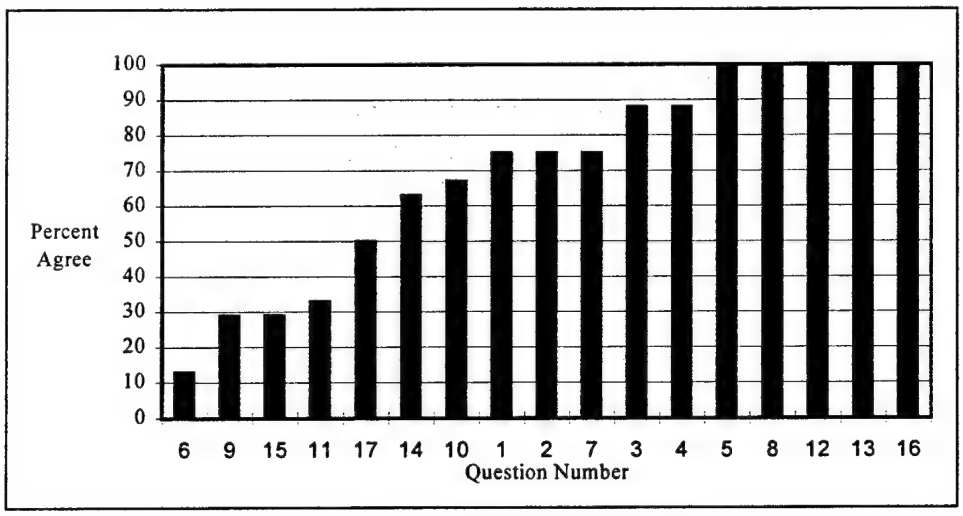

Figure 4. Expert Responses by Percent Agree

Using the 60 percent threshold identified previously, questions 14, 10, 1, 2, 7, 3, 4, 5, 8, 12, 13, and 16 attained a consensus agreement by the experts. Questions 5, 8, 12, 13, and 16 attained perfect consensus with all experts rating the statements agree or strongly agree. Using the same procedure, Figure 5 indicates which statements the

respondents disagreed with. The percent of expert disagreement is the indicator of whether consensus was reached by the experts as to disagreement with a particular statement.

Using the 60 percent rating as before, none of the questions were identified as reaching consensus for disagreement. Questions 15, 11, and 6 were disagreed with by a notable amount, however. This will be discussed in the question-by-question analysis.

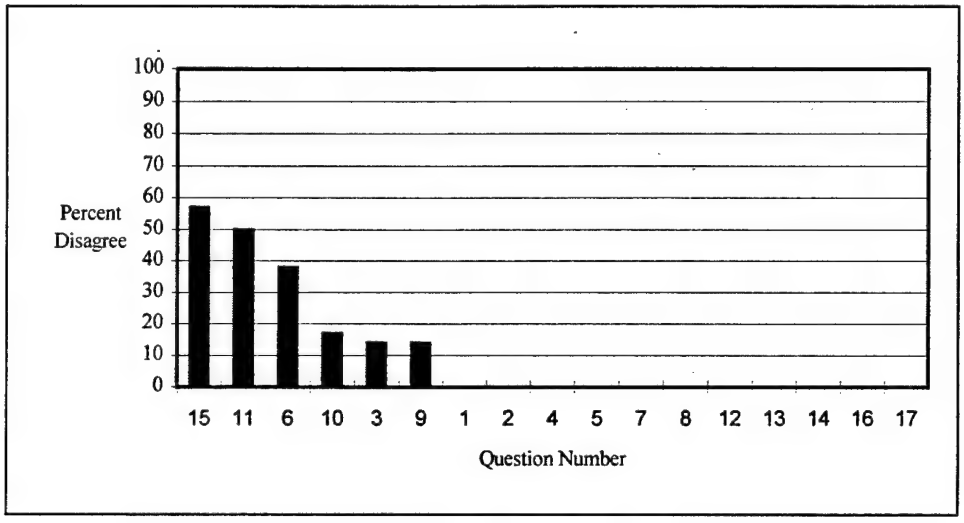

Figure 5. Expert Responses by Percent Disagree

The mean score of the responses for each question was also used as a second measure of consensus. A mean score above 3.4 was used to indicate agreement consensus and a mean score below 2.6 was used to indicate disagreement consensus, with these ratings again indicating scores in the top or bottom 40 percent. Figure 6 shows the mean ratings of the experts' answers on each question.

As the table indicates, questions 17, 10, 14, 13, 7, 8, 1, 2, 3, 5, 12, 16, and 4 (in ascending order) were identified as questions upon which the experts were in agreement. The only question identified as reaching agreement consensus using this method that was

not previously identified was question 17. Question 15 was identified as achieving disagreement consensus using this method. As previously noted, questions 6, and 11 have notable indications of disagreement which will be identified during the question-by-question analysis.

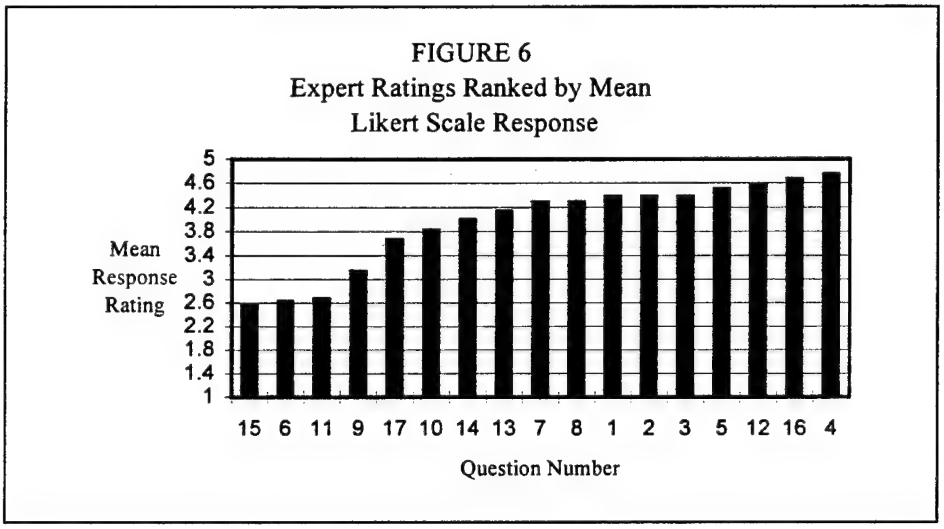

Figure 6. Expert Ratings Ranked by Mean Likert-Scale Response

Due to the small sample size of the expert panel (8 valid respondents), the conclusions will not make any statistically significant claims, but rather will attempt to give the reader a reasonable indication of what the data means and its applicability toward answering the research questions.

Question-by-Question Analysis

1. Imaging is most valuable to an organization when it is a result of a comprehensive review of business processes.

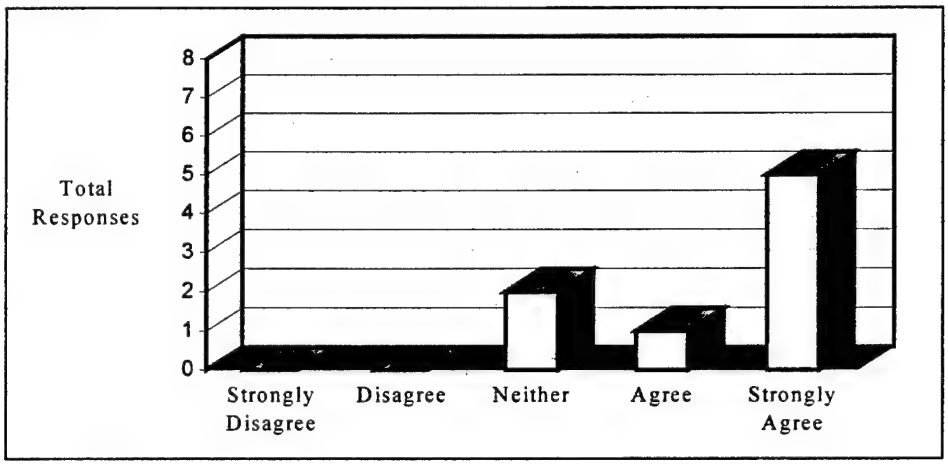

Figure 7. Response Distribution - Question 1

Question 1 had a mean response of 4.38 and an agree percentage of 75 percent with no disagrees. These scores indicate consensus of agreement by the experts for this statement. This statement established strong support that document imaging should be used as part of a complete business process review.

2. Successful imaging projects require aggressive support of top organizational leadership, with a willingness to promote change.

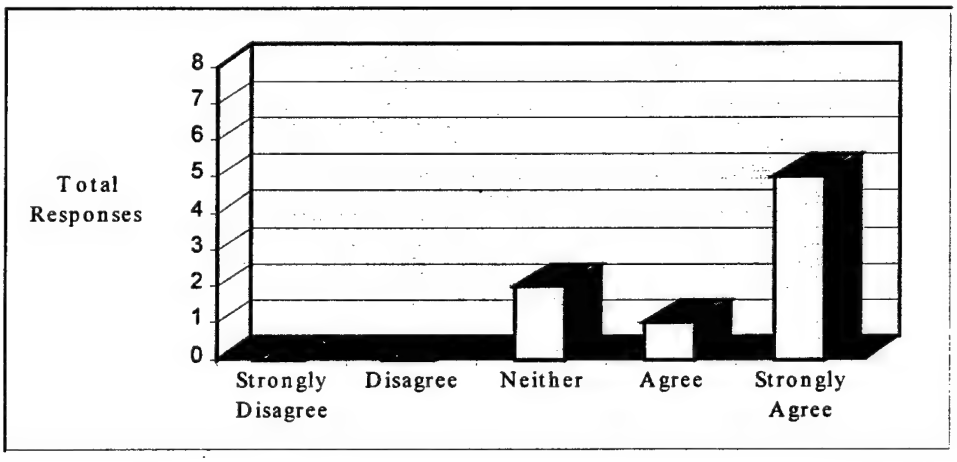

Figure 8. Response Distribution - Question 2

Question 2 had a mean response of 4.38 and an agree percentage of 75 percent with no disagrees. These scores indicate consensus of agreement by the experts for this statement. This statement identifies the importance of top management support to the success of an imaging project. This is not unique to imaging, top management support is often identified as critical to any IT project's success. This does highlight its importance in the opinions of our experts.

3. Information must be viewed as an extremely valuable corporate resource in order for imaging to reap its greatest benefits.

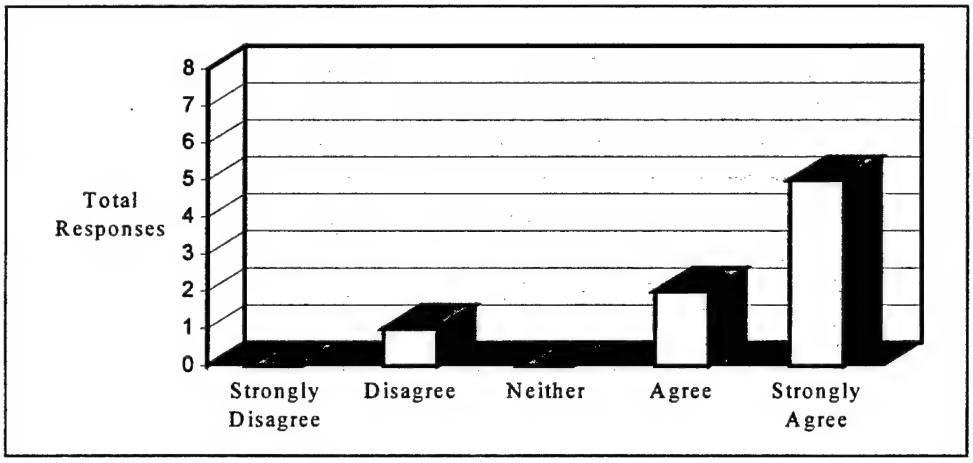

Figure 9. Response Distribution - Question 3

Question 3 had a mean response of 4.38 and an agree percentage of 88 percent with a disagree percentage of 13 percent. These scores indicate consensus of agreement by the experts for this statement. This statement identifies the importance of information being treated as a valuable organizational resource for imaging to provide its greatest benefits. It is not unusual that this group of experts highly supports this statement as they are nearly all professionally committed to information resource management as a discipline.

4. Imaging is not a one-time investment which results in immediate savings to the organization.

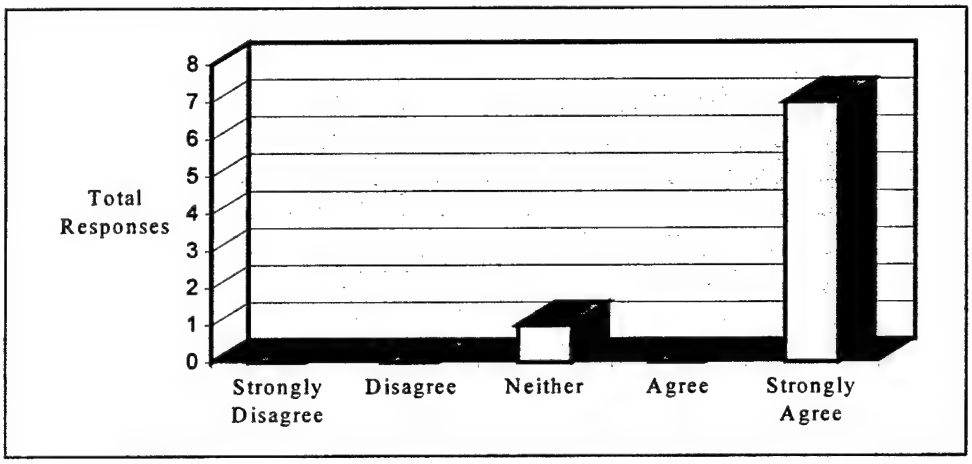

Figure 10. Response Distribution - Question 4

Question 4 had a mean response of 4.75 and an agree percentage of 88 percent with no disagrees. These scores indicate consensus of agreement by the experts for this statement. The lesson to be learned by this statement's results is that we should look at imaging as a long-term solution to a business problem. The experts were nearly unanimous in their strong agreement with this statement. It highlights the potential for incurring ongoing costs past those initially planned for an imaging project and the long-term focus an imaging project should maintain.

5. Timely access to information is critical to the continued success of the organization.

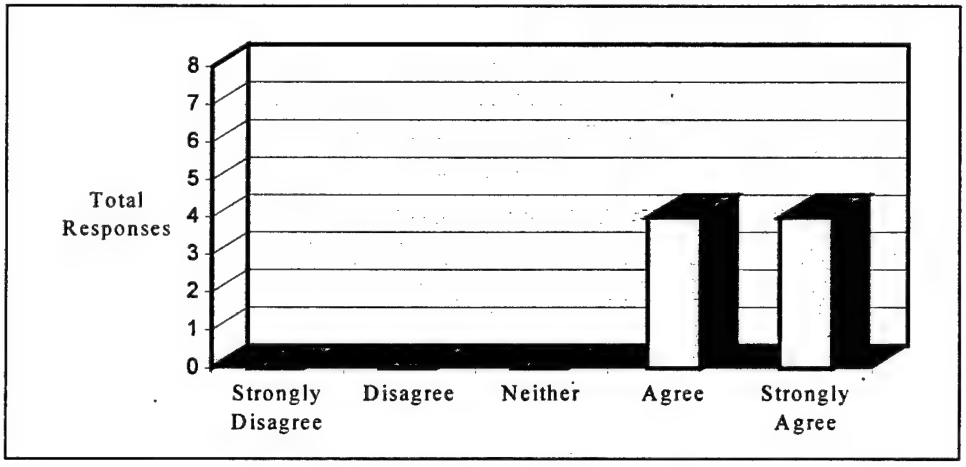

Figure 11. Response Distribution - Question 5

Question 5 had a mean response of 4.50 and an agree percentage of 100 percent with no disagrees. These scores indicate total consensus of agreement by the experts for this statement. Unanimous agreement by the experts again shows the importance this group of professionals places on the value of information to an organization's success. This statement is not strictly identified with document imaging, but with the overall strategic importance of getting the right information, to the right place, at the right time.

6. A key cost consideration of an imaging project is the savings achieved by decreasing the paper record holdings of the organization.

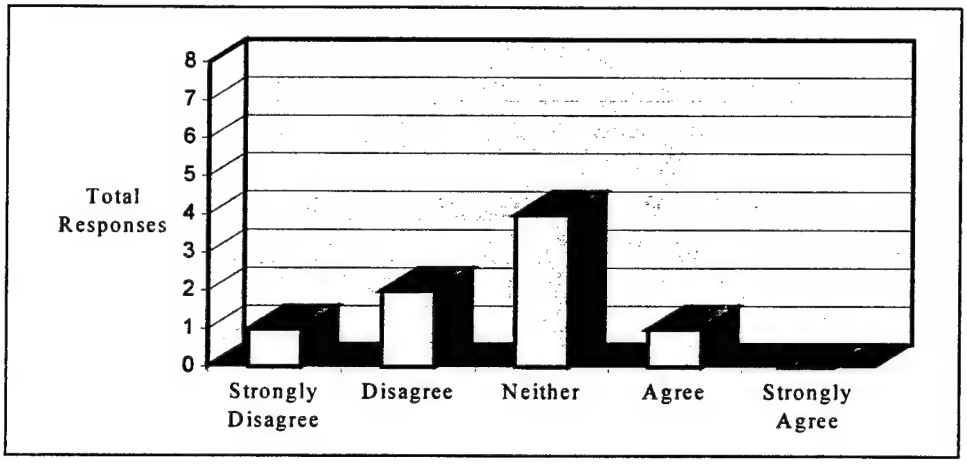

Figure 12. Response Distribution - Question 6

Question 6 had a mean response of 2.63, an agree percentage of 13 percent, and a disagree percentage of 38 percent. These scores indicate neither consensus of agreement nor disagreement by the experts for this statement. This statement had the third highest disagreement percentage of the 17 rated. Although consensus of disagreement with this statement was not attained, it does show that there is some indication that cost savings by decreasing our paper holdings is not a primary benefit of an imaging system. This is interesting, since some of the literature which involves trying to quantify the benefits of document imaging point to decreased paper holdings as a key quantifiable area of savings.

7. Appropriate training is important to successful imaging technology implementation.

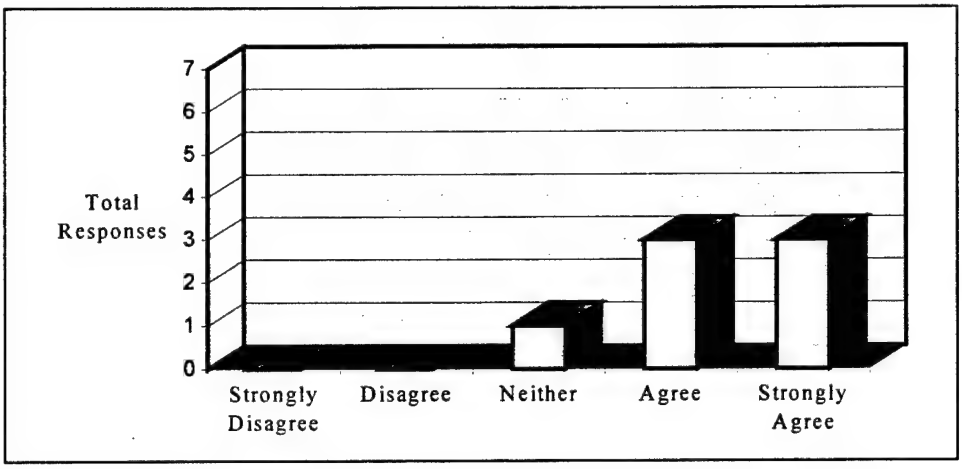

Figure 13. Response Distribution - Question 7

Question 7 had a mean response of 4.29 and an agree percentage of 75 percent with no disagrees. These scores indicate consensus of agreement by the experts for this statement. The experts agree as to the importance of training to an imaging project's success. This is understandable, given the high emphasis placed on training in the USAF.

8. Training is a recurring need with recurring costs which should be incorporated into budgets and long-range plans.

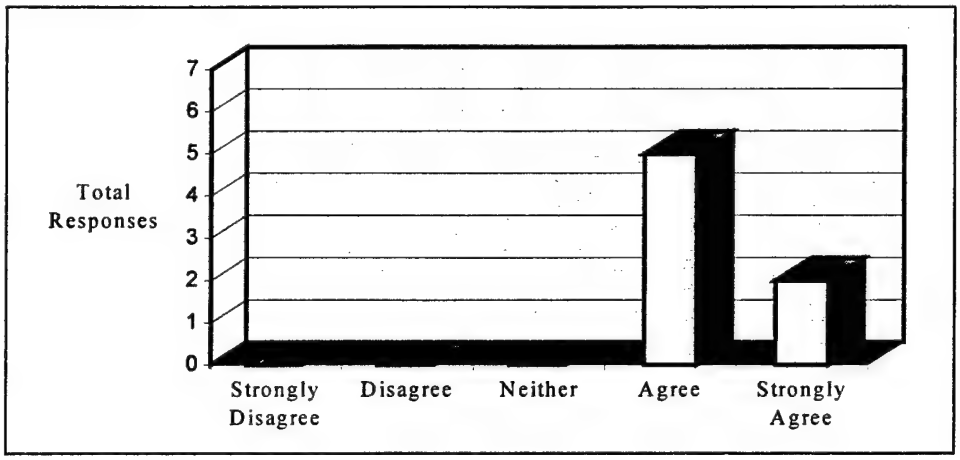

Figure 14. Response Distribution - Question 8

Question 8 had a mean response of 4.29 and an agree percentage of 100 percent with no disagrees. These scores indicate total consensus of agreement by the experts for this statement. As in the previous question, this statement points to the importance of considering training costs and issues if we wish to be successful in an imaging project. This statement identifies the importance of factoring initial and on-going training costs into our cost calculations for an imaging project. This area is often overlooked in the literature attempting to cost justify an imaging solution.

9. A successful imaging project relies upon long-term alliances developed with key vendors in imaging technology.

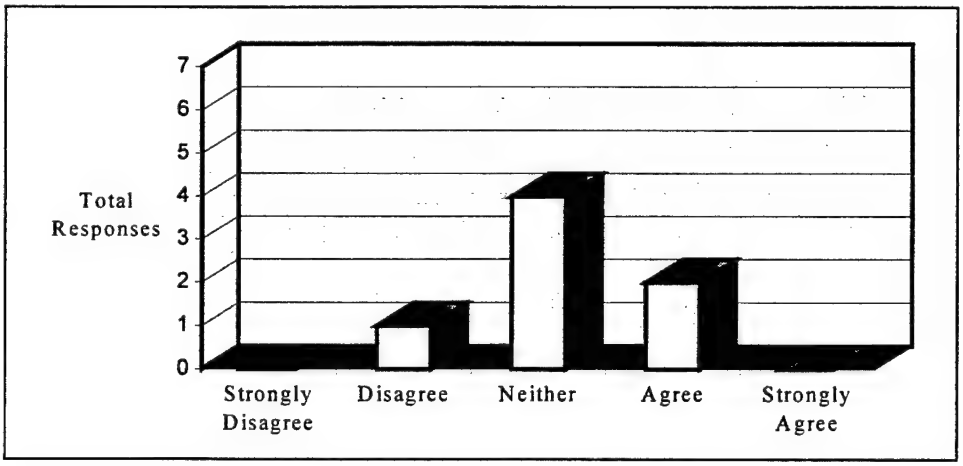

Figure 15. Response Distribution - Question 9

Question 9 had a mean response of 3.14, an agree percentage of 29 percent, and a disagree percentage of 14 percent. These scores indicate neither consensus of agreement nor disagreement by the experts for this statement. A lack of agreement or disagreement by our experts may indicate a neutral effect of long-term relationships with imaging vendors. Given the strong emphasis the experts placed (in their open-ended responses) on basing an imaging solution on an open, standards-based imaging solution this would be a reasonable conclusion. By basing our systems on non-proprietary formats, we would be less reliant upon any one vendor for providing long-term imaging support.

10. Imaging is most appropriate for documents which are frequently accessed from multiple sites.

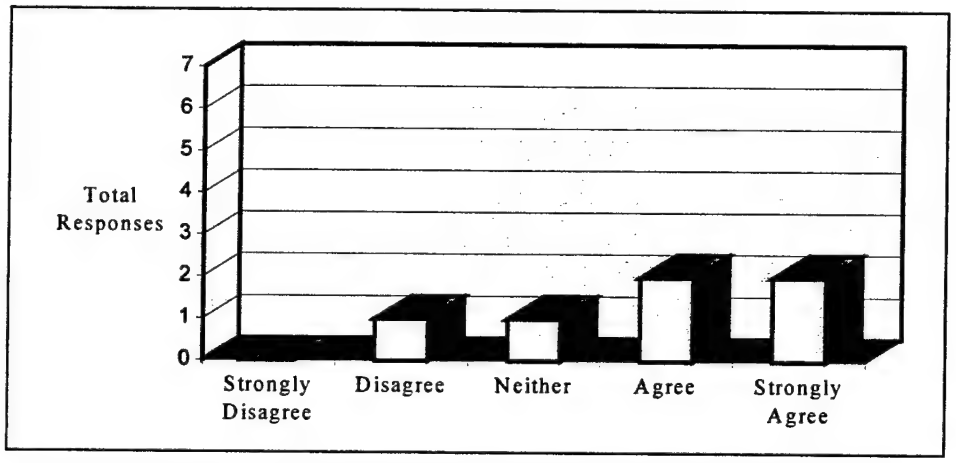

Figure 16. Response Distribution - Question 10

Question 10 had a mean response of 3.83, an agree percentage of 67 percent, and a disagree percentage of 14 percent. These scores indicate consensus of agreement by the experts for this statement. This statement identifies an often cited benefit of document imaging—increased accessibility. The experts consensus of agreement with the statement supports this benefit and helps us to identify documents which will be best suited to an imaging solution.

11. Imaging is best used for documents in which graphic (as opposed to strictly textual) information is vital.

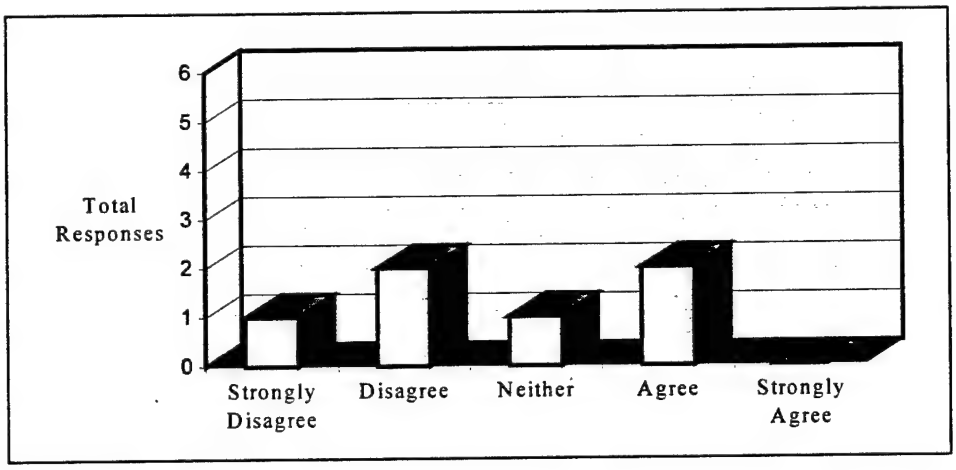

Figure 17. Response Distribution - Question 11

Question 11 had a mean response of 2.67, an agree percentage of 33 percent, and a disagree percentage of 50 percent. These scores indicate neither consensus of agreement nor disagreement by the experts for this statement. Although consensus was not reached, the scores for this statement are definitely skewed toward disagreement by the experts. This statement received the second highest disagreement rating of the 17 statements. The disagreement to this statement may be an indication of the experts' experience with imaging systems which primarily deal with text-based documents. It may also be a result of the wording of the statement. It uses the word "best" which may cause the disagreement. Document imaging clearly allows us to manipulate graphic information well (engineering drawings, photographic holdings associated with historical documents, etc.), but it may be that typical usage of document imaging is for handling high-volume paper-based textual information.

12. Document imaging is most effective when it is used as part of a total document management system.

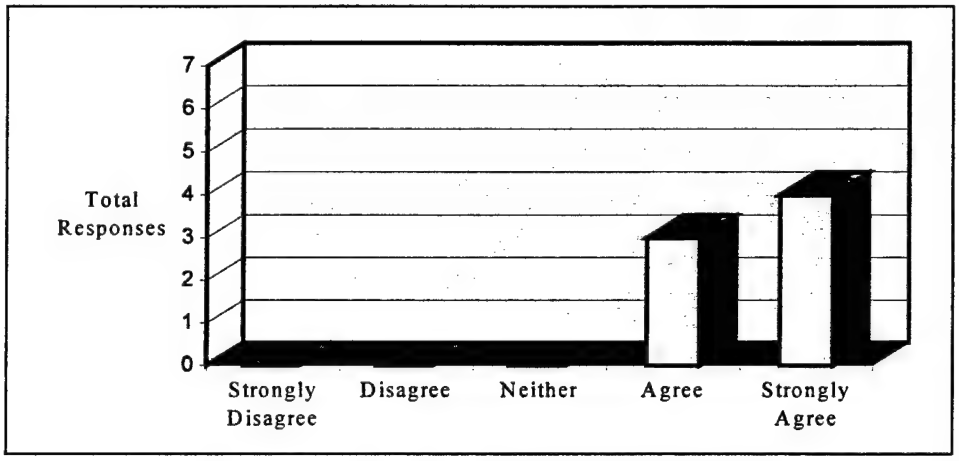

Figure 18. Response Distribution - Question 12

Question 12 had a mean response of 4.57 and an agree percentage of 100 percent with no disagrees. These scores indicate total consensus of agreement by the experts for this statement. The level of agreement for this statement shows the importance our experts place on using imaging as a part of an overall electronic document management system. During the open-ended responses by our experts, this theme was emphasized several times. Document imaging is not an end unto itself, but rather part of a whole solution to managing information effectively.

13. Information which is critical to business operations, the loss of which would cause significant resources to recover, is a prime candidate for imaging.

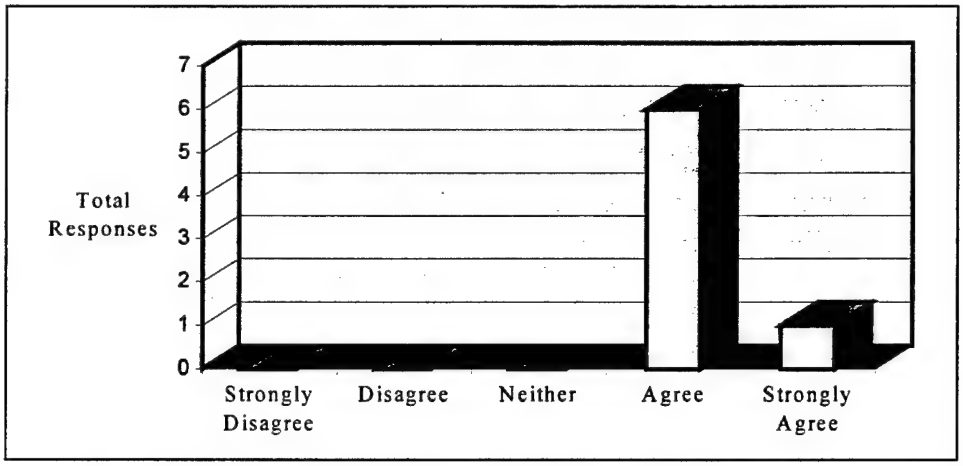

Figure 19. Response Distribution - Question 13

Question 13 had a mean response of 4.14 and an agree percentage of 100 percent with no disagrees. These scores indicate total consensus of agreement by the experts for this statement. The agreement on this question underscores a key benefit of document imaging—security. An imaging system, when used to provide backups of critical documents, can provide security unparalleled by maintaining the information in a single paper-based record keeping system. We can create numerous copies of our critical documents and store them at various sites. This can help protect them from physical destruction due to natural disasters or loss due to mishandling or theft. This is unfeasible to do this with paper records because of cost and logistical constraints.

14. The non-quantifiable (e.g. customer service, workflow improvement) benefits of imaging often outweigh the quantifiable (e.g. manpower savings, storage costs) benefits.

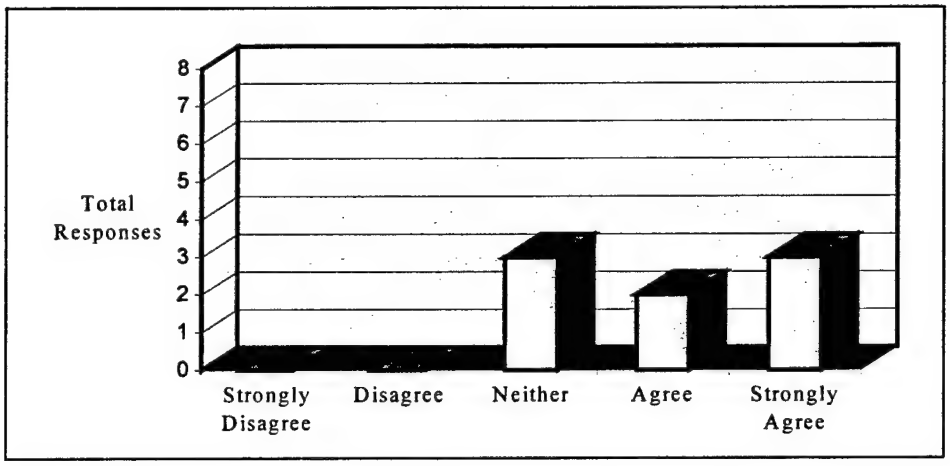

Figure 20. Response Distribution - Question 14

Question 14 had a mean response of 4.00, an agree percentage of 63 percent, and no disagrees. These scores indicate consensus of agreement by the experts for this statement. Agreement on this statement was widely dispersed, though toward the agree side of the scale. This may indicate the range of the experts experiences with imaging. Some indicated that they didn't have to cost-justify their system because the business process dictated imaging as a solution, regardless of cost. Others indicated lack of experience with implementing a system, their experience consisting of an advisory role to those considering an imaging project. In this function, the funding for the project would not be the concern of our expert. This statement directly relates to research question number 1: "What are the primary cost factors involved in an ADC project, both tangible and intangible?" It identifies the difficulty we face in determining the quantifiable costs associated with document imaging.

15. Decreasing manual storage costs of records is a primary reason to implement document imaging.

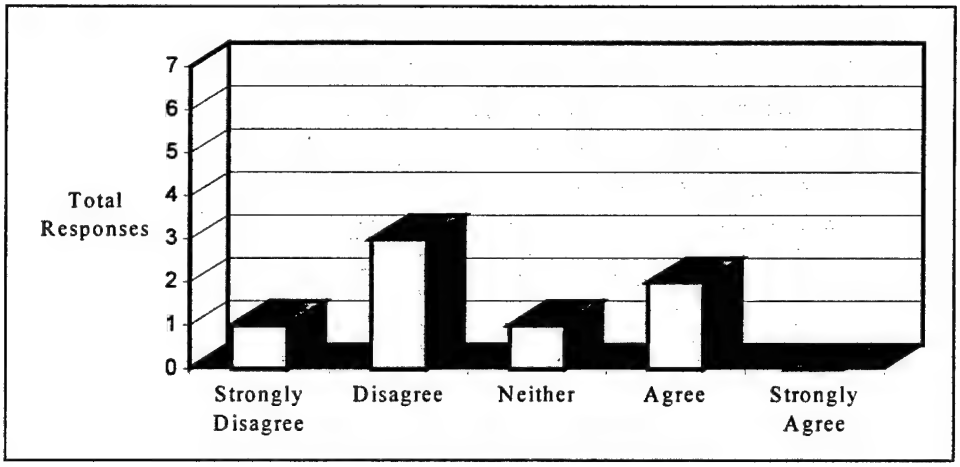

Figure 21. Response Distribution - Question 15

Question 15 had a mean response of 2.57, an agree percentage of 29 percent, and a disagree percentage of 57 percent. These scores indicate consensus of disagreement by mean response but lack of consensus of disagreement by disagree percentage for this statement. This skewing of the responses to the disagree side indicates weakened support for an often cited reason to implement document imaging—decreased paper-based record keeping costs. It also shows the tendency for our experts to support business process improvement as the primary benefit of an effective imaging system.

16. Basing an imaging system on an open and standardized system (like Tagged Image File Format - TIFF) is a major consideration for the success of an imaging system.

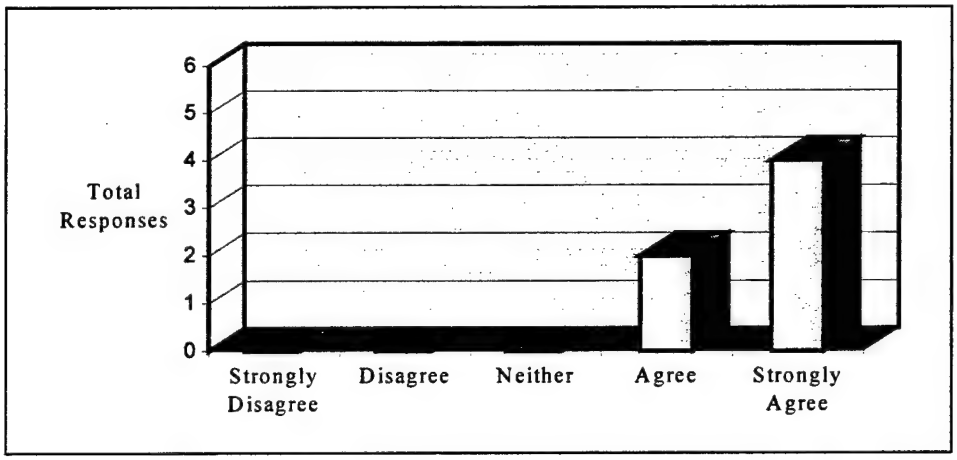

Figure 22. Response Distribution - Question 16

Question 16 had a mean response of 4.67 and an agree percentage of 100 percent with no disagrees. These scores indicate total consensus of agreement by the experts for this statement. The scores for this question are the second highest for agreement by the experts. The experts identified the importance of basing an imaging solution on an open, standards-based system often during the open-ended answers. This key idea was espoused from the most to the least experienced individuals in the group. Stay away from proprietary systems, and concentrate on a system which allows eventual upgrading to another system (software or hardware) with a minimum of challenges. This supports the DoD's strategy for document conversion identified in the ADCMP which is a two-step process. First convert the document to a standard format (ASCII, EBCDIC, etc.) and then once you've established a standards-based foundation, convert to the format required by your particular hardware/software selection.

17. Migration of digital documents to future platforms will constitute a significant portion of imaging costs.

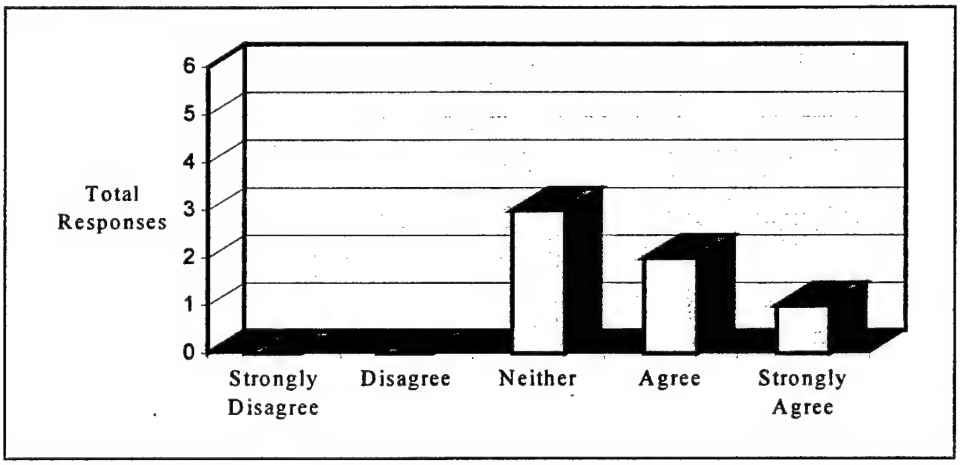

Figure 23. Response Distribution - Question 17

Question 17 had a mean response of 3.67, an agree percentage of 50 percent, and no disagrees. These scores indicate consensus of agreement by mean response, but lack of consensus by agree percentage for this statement. The lack of strong agreement with this statement may be because migration costs will not constitute a significant portion of costs, or the experts have not yet experienced the costs of migration. Without specifically addressing this with the experts, I can not make any assumptions about the significance of this statement's results. There was mention of migration costs in the open-ended answers which will be discussed later in this chapter.

Summary of Scaled-Response Analysis

This section attempted to determine any information identified during the scaled-response section of the survey which would help answer the research questions of this study. While the analysis was primarily qualitative in nature, some very basic statistical analysis was used to help give the reader an indication of whether the experts agreed or disagreed with the statements in the survey. The actual responses by each expert to each

question are listed in Appendix C and allow the reader to examine the data as desired. My analysis was intended to be a reasonable interpretation of what the experts were telling us by their responses to the survey.

Open-ended Question Analysis

Section III of the survey consisted of 11 open-ended questions designed to elicit the experts' opinions on various facets of document imaging. The following section will attempt to synthesize the responses of the experts and identify key information in their responses pertaining to the research questions. The full responses to each question by each expert are included in Appendix D for the reader's review. There are some very insightful recommendations and information in the responses which may not be captured in this analysis and it is recommended that the reader review the actual responses to fully glean the useful information contained therein.

18. What are some of the major benefits of an imaging system?

Provides rapid access to documents. Decreases storage space required for information. Allows for historical preservation of sensitive documents. Potentially produces higher quality document than original. Enables economically feasible duplicate files and archives. Decreases labor costs for manual document handling. Facilitates structured workflow improvements, collaborative use of documents, greater document protection (fewer lost documents, restricted access, etc.), and ease of transportability of documents (electronic transfer across distances, quickly).

19. What would your advice be to a manager who is considering implementing an imaging system?

Do not become enamored with technology, focus on improving business processes. Imaging should be implemented when it is a result of a business process reengineering effort which identifies imaging as a solution to a problem. Stay away from proprietary systems and software solutions. Imaging is not a panacea, you can't cure a broken process by automating it. Carefully determine your requirements and thoroughly research your options across various price ranges, concentrating on open, standards-based solutions. Get users committed to a system through personal involvement in requirements determination, system design, and implementation. User commitment is critical to the long-term success of a project. Imaging should be used as an adjunct to an effective workflow management system; it should provide a way to input paper documents into an effective electronic document management system. Be aware that imaging is expensive and requires an ongoing expenditure of resources (capital and labor) to remain viable. Be wary of potential manpower savings—imaging may be more manpower intensive depending upon the application.

20. What areas would you emphasize when developing an economic analysis of an imaging project?

Initial procurement costs. Life-cycle costs of software/hardware maintenance (upgrades, expansion, or migration to new technologies). Outyear costs of imaging versus status quo. Replacement costs of lost or misfiled documents. The value of improved access to information. Document conversion costs. Indexing costs (how much information is needed to quickly and accurately locate a document). Cost of running

manual system and electronic system concurrently during implementation. Disaster recovery costs. Data migration during system initiation.

21. What is the likelihood of justifying an imaging application based upon clearly identifiable/quantifiable cost savings?

Responses ranged from unlikely to very likely, possibly based upon that individual's experience with attempting to quantify an imaging solution using a structured cost analysis methodology. Experts experienced difficulty in quantifying cost savings for improved access, process improvement, better customer service—the primary reasons for implementing an imaging solution.

22. What lessons have you learned that you wish you would have known prior to embarking on an imaging project?

Potential value of automatic indexing. The importance of open versus proprietary systems. Beware of vendor claims which minimize the importance of standards-based systems. Senior-level involvement is critical to success. Involve users from the beginning and keep them involved. Be open to inputs from many sources when defining requirements. Clearly understand the capabilities and limitations of imaging. Indexing is the key to rapid retrieval. Document preparation and scanning is labor intensive. Cost of upgrades is more substantial than expected. Imaging is difficult to justify based on cost savings. Choose backfile conversion method carefully, it can get real expensive otherwise.

23. What are the primary cost factors involved in an automated document conversion project, both tangible and intangible?

Hardware, software, maintenance, upgrades (both hardware and software). Backfile conversion costs (document preparation, scanning, error detection and

correction). Temporary loss of use of documents during conversion. Labor costs (if done in-house double man-hour costs because people will now have two jobs, the imaging project and their normal job). Value of improved access.

24. What are the major benefits reaped by an effective document conversion project?

Quicker access to information (with proper indexing) by multiple users. Decreased physical storage requirements. Document preservation. Ability to store duplicate information in many locations (disaster recovery, increases access to information).

25. Which activities/processes are best suited to ADC with regard to return-on-investment and mission effectiveness?

Activities whose success is dependent upon rapid access to information. Archival management for historical/research purposes. "Assembly-line" operations (well-structured, repetitive processes). Activities with high paper output which benefit by extensive use of the information. Activities which require strong document control.

26. If faced with cost justifying an imaging application, what would you identify as the major benefits associated with document imaging?

Reduced need for file clerks. Decreased storage costs. Decreased manual retrieval costs. Improved responsiveness to requests for information.

27. Is there anything you want to include in the conclusions of this research?

"Open systems are a must, proprietary systems can become an expensive dead-end." "Imaging is essential to efficient storage and retrieval of rapidly increasing quantities of information." "This technology is not inexpensive to acquire or support, if you plan to go with the cheap solution, don't even start." "Document imaging is a

component of an effective electronic records management system. The real benefits are realized when documents are created, circulated, protected, and archived in electronic form and are only printed when absolutely necessary. The ideal is a cradle-to-grave records management system which complies with all aspects of information management including security classification."

28. What factors would you use to determine the applicability for using an imaging system?

Frequency of access of the information. Storage costs of information by other means. Access requirements for the information, Potential for process improvement due to imaging. Compliance with records management policies/procedures. Total cost of the system (conversion, operating, and lifecycle).

Findings

Research question 1, "What are the primary cost factors involved in an ADC project, both tangible and intangible?", was addressed by survey questions 6, 7, 8, 15, 17, 20, and 23 (specifically). Reviewing the results of the experts' answers to these questions should provide us with the answer to research question 1.

Survey question 6 was, "A key cost consideration of an imaging project is the savings achieved by decreasing the paper record holdings of the organization." Survey question 15 was, "Decreasing manual storage costs of records is a primary reason to implement document imaging." Both questions are related to the cost savings of an electronic records management system versus a paper-based system. Question 6 did not attain consensus of disagreement, but it was disagreed with significantly. Question 15 was the only question which reached a consensus of disagreement by our experts.

Therefore, caution is urged when using decreased storage, handling, and resource costs for paper-based records as a primary cost factor of ADC. This factor is often used in a economic analysis of ADC projects because it is fairly concrete and easy to calculate. The cost savings (file clerk manpower, storage costs, paper costs) often identified in ADC sales literature are may be offset or even exceeded by an ADC project. Imaging systems are often cost-justified using the manpower savings as a major source of savings. The manpower reductions of file clerks to manage the paper records may be offset by increased information systems personnel to run the imaging system. The decreased storage costs of electronic records versus paper records can easily be offset by the expense of the imaging hardware, software, and training expenses.

Survey questions 7 and 8 ("Appropriate training is important to successful imaging technology implementation." and "Training is a recurring need with recurring costs which should be incorporated into budgets and long-range plans.") point to the importance of training costs, both initial and recurring, as a factor in document imaging. Both questions were agreed with by consensus of our experts, question 8 achieving total agreement and neither question being disagreed with. While initial training costs are sometimes factored into an imaging cost analysis, ongoing training costs (for new personnel and system upgrades) are often overlooked; this research points to this as a deficiency.

Survey question 17 was, "Migration of digital documents to future platforms will constitute a significant portion of imaging costs." It was agreed with by the experts using the mean score method of reaching consensus. This could indicate our experts believe migration costs are significant when considering an imaging system.

Survey Question 20 was ,"What areas would you emphasize when developing an economic analysis of an imaging project." The answers to this question were synthesized and addressed previously. They provide us with cost factors to consider in an imaging project.

Question 23 was, "What are the primary cost factors involved in an automated document conversion project, both tangible and intangible?" It was a direct attempt to get an answer to research question 1. The responses as in the previous question were summarized in the previous section - Open-ended Question Analysis. The responses also identify the experts' opinions as to some primary cost factors for a document imaging system. While the factors identified are not an exhaustive list of key cost factors, the responses are valuable in that they support many of the imaging cost factors identified in the literature.

Research question 2 was, "What are the major benefits reaped by an effective document conversion project?" Survey questions 14, 15, and 26 (specifically) were related to this research question.

Question 14 indicates that our experts feel the non-quantifiable benefits of document conversion often outweigh the quantifiable benefits. This highlights the importance of considering more than just clear cost justification as a determination for a document conversion project. It also may point to the difficulty associated with identifying and quantifying the cost factors of document conversion.

Question 15 was discussed previously in research question 1. It also applies here, because the literature often cites a major benefit of document imaging as being decreased storage costs. As previously mentioned, the experts disagreed with this statement,

weakening this argument. While it is apparent that there may be decreased storage costs, the significance of this factor in the overall cost justification is low, when compared to other factors like increased document accessibility, security, and process improvement.

Research question 3 was, "Which activities/processes are best suited to ADC with regard to return-on-investment, and mission effectiveness?" Survey questions which addressed this research question were numbers 10, 11, 13, and 25 (specifically).

The results of survey question 10 identified frequently accessed documents as well suited to ADC. Survey question 11 had mixed results with regard to this research question. It did not rule out the importance of imaging for documents in which graphic (as opposed to strictly textual) information is vital, neither did it support this statement. The experts' responses to this statement indicate a relative lack of importance of this statement, however.

Survey question 13 was, "Information which is critical to business operations, the loss of which would cause significant resources to recover, is a prime candidate for imaging." It received unanimous agreement by the experts. This strongly identifies this statement as an important identifier of activities which are suited to ADC.

Survey question 25 was specifically designed to address research question 3. The results of this question were summarized previously in the analysis of the question. The responses to this question were fairly short and vague. It is unclear whether this is because the question was vague or misunderstood, or the experts just didn't have many suggestions for activities which would most benefit by ADC. Overall, this research question was not strongly addressed in the results of this survey.

Further Analysis - Literature Review and Survey

During the document review portion of this research, an extensive search was conducted to identify documents which could covered key factors associated with successful document imaging projects and key cost factors associated with document conversion. While numerous documents were found which covered these topics, there was a general versus specific nature to the documents. Additionally, two of the individuals who participated in the survey portion of this research provided documents which provided information relevant to this research focus.

One document is a prototype functional economic analysis methodology which serves three purposes: identifying annual costs of various record series, identify records which are good candidates for changes to the way in which they are maintained, and to provide a way of measuring the effectiveness of changes in records management, including document imaging projects (Long, 1994:1).

This publication provides us with a structured methodology to determine the costs of maintaining a particular record series. This cost can be used as an input to determine the cost effectiveness of various records management methods (manual or electronic.) The report can be valuable to IRM professionals considering imaging for a records management application.

While this document does not address the non-quantifiable aspects of an imaging solution, it should prove to be very helpful to ascertain quantifiable aspects of records management. The reader will find the complete report and an example spreadsheet implementation of the methodology in Appendix E.

Comparison of Document Review and Survey Results

The following section will identify the cost factors, benefits, and recommended projects for an imaging project as proposed in the documents reviewed during this study. Information supported or refuted by the results of the survey will be noted appropriately. The sources for the following information were extensively, but not exclusively, Attinger, Avedon, Gable, Langemo, and Robinson.

Imaging Cost Factors

Imaging Hardware: Cost of scanners, computers, monitors, high-speed printers, optical disks, jukeboxes, archival storage.

Imaging Software: Imaging and workflow software.

Training: Initial and recurring training for image management personnel.

Information Infrastructure: Possible upgrades to Local Area Network due to increased traffic from image data. Imaging can cause system throughput to be exceeded rapidly as users become more reliant upon system. This can be a hidden cost not normally considered in a cost analysis.

Data Migration: Cost of migrating to new hardware or software as system becomes obsolete. Costs can be substantial due to rapidly changing technology. Migration costs can be minimized by ensuring non-proprietary, standards-based imaging solution is purchased initially.

Document Conversion: Initial conversion costs consist of document preparation, labor, indexing, quality control. Choose conversion strategy carefully, can become very expensive to convert documents which have little or no access requirements.

Document Handling: Refiling folders after use; filing documents into folders; sorting documents prior to filing; pulling files for users; purging old files; searching for lost documents; sending documents off-site; mailing documents within organization.

Labor: Number of personnel involved in document handling; percentage of their time associated with handling; salaries and fringe benefits; supervisory costs; administrative overhead costs.

Storage Space, Equipment, Supplies: On-site storage space; off-site storage; file cabinets; supplies (folders, paper, copier supplies); copier lease and maintenance.

Soft Costs: Lost files/documents; slow response time; insufficient information to make decisions.

Imaging Benefits

Improved access to documents: Documents can be accessed from multiple, geographically separated locations; historical documents not previously accessible; remote access; high volume of documents available on-line.

Remote access to information: More than one user has access to document at same time; concurrent document creation with workflow software; revision histories can be tracked; decreased mail and express courier costs.

Fewer lost documents: Better control of documents electronically; decreased lost or misplaced documents than manual system.

Reduced storage costs: Frees up valuable office space from file cabinets, eliminate off-site storage costs.

Reduced duplication costs: Fewer copies made of documents due to electronic availability for reference (be careful of this one—more copies may be made because people are still more comfortable with paper).

Improved worker productivity: Employees spend less time searching for documents; have access to information needed to make proper decisions; decrease information flow bottlenecks; simultaneous workflow for previously done sequentially; potential for indexed, keyword searches of huge document repositories.

Increased security: Can limit access to electronic documents through software.

Improved customer service: Immediate response to requests for information; shorter processing time; up-to-date more accurate information.

Disaster recovery capability: Can create multiple backup copies of critical documents at reasonable cost; backups can be stored off-site cheaply.

Reduced filing costs: Less administrative personnel required for file access and maintenance; decreased redundant files and associated costs.

Competitive advantage: Lower cost of doing business; improved efficiency; eliminate file processing delays; improved productivity through reduced retrieval time; shortens time-to-market due to collaborative workflow capability.

Better document output quality: Potentially better quality output than xerographic copy; on-screen document enhancement of poor quality images.

Recommended Imaging Applications

High retrieval-rate documents: Documents with high retrieval-rate have high imaging value; avoid little-used documents.

Historical archives: Documents which can not be accessed physically due to location, volume, or fragility.

Collaboratively developed documents: Documents created as a result of collaborative process between various employees and locations (marketing plans, engineering blueprints, architectural drawings); workflow software can be used to concurrently develop various aspects of documents previously developed sequentially; processes often cross departmental boundaries.

High-volume document library: Applications which have a large library of documents which need to be accessed quickly using indexed, keyword searches (law library, medical library).

Timely access requirements: Documents in which timely access is critical to success (customer service information, medical files, safety information in hazardous industries).

Multimedia Documents: Increasingly common graphics-intensive, multimedia documents incorporating pictures, sounds, or movie clips.

High knowledge-content documents: Documents which contain high level of knowledge content like scientific research (increased access means increased use of valuable information by other researchers).

Authenticated documents: Documents contain official seals, signatures, or handwritten authentication which is essential to establish validity of the document.

Summary

This chapter analyzed the results of the surveys received from eight experts in the document imaging field. It began with a section reviewing the experts responses to the

demographic section of the survey. The results of the first seventeen questions of the survey were then discussed, with the goal being to identify consensus of agreement or disagreement. The possible meaning of a particular question's results was proposed, with emphasis toward relating it to the research questions. The chapter then discussed the open-ended questions by synthesizing the experts' responses to each question.

Further analysis was conducted with an additional search through the literature, identifying imaging cost factors, imaging benefits, and recommended imaging applications. The information in the literature search was then combined with the survey results and compiled into findings which should prove useful to individuals considering automated document conversion or document imaging applications.

The method of analysis in this chapter was not an attempt to provide statistical validity to the findings of the research, but rather an effort to provide the reader with an indication of the level with which our experts agreed with definitive statements. The information identified during the analysis of the survey results was then combined with the information extracted during the final literature review. The information was consolidated into sections corresponding to the three research questions identified in the study.

Several scaled-response questions in the survey produced significant findings worthy of noting here due to the unanimous agreement they engendered in the experts. The experts all agreed that: timely access to information is critical to continued success of an organization, training is a recurring need with recurring costs which should be incorporated into budgets and long-range plans, document imaging is most effective when used as part of a total document management system, critical information for a

business is a prime candidate for imaging, and basing an imaging system on an open, standards-based architecture is critical to the success of the system.

Chapter V contains all of the information extracted from the surveys and the document review, and presents it in a way which is directly related to the research questions of this study. It also discusses some interesting "lessons learned" by the experts which have some strong and valuable lessons for managers considering document imaging as a solution to a business problem.

V. Conclusions

Overview

This final chapter summarizes Chapters I through III and the findings identified in Chapter IV. The practical implications of this research are discussed. Some recommendations are then made for follow-up research which may complement or further validate this study.

General Issues Driving This Research

The basic issue addressed in this thesis was identifying the pertinent information a manager would need to determine which applications would be most cost and mission effective for automated document conversion (also referred to as document imaging throughout this study.) This requirement exists because technological advances in our work methods have made electronic documents more pervasive throughout the USAF, DoD, and civilian world. Our focus on paper-based records management techniques has caused us to overlook effective management of the increasing volume of electronic documents. While attempts have been made in various organizations to utilize document imaging to more efficiently handle our workflow, these have often been unique, application-specific systems. The knowledge acquired by the implementers of these systems has not been shared with other managers on a large scale. This thesis attempted to consolidate some of this valuable information into one source which could help managers determine which applications and processes in their workplaces would benefit most by application of document imaging technology.

Specific Problem Addressed in this Study

As originally stated in Chapter I, the requirement to effectively utilize scarce resources within an organization is a problem facing all managers within the DoD and in the civilian world. Managers considering ADC as a solution for various business processes in their organization need an effective method to determine which activities will provide them with the greatest operational returns on their resource investment. This thesis addressed the problem of developing a practical solution to identify appropriate ADC activities and processes which would provide the greatest mission impact. It also attempted to identify the primary cost factors managers need to consider when attempting to determine which ADC activities and processes are most cost effective.

Research Questions Answered

In order to answer the research problem identified in this study, the following research questions were addressed and answered by the results of a document review and survey of experts in the document imaging field:

1. What are the primary cost factors involved in an ADC project, both tangible and intangible?

   Imaging hardware, imaging software, training, information infrastructure, data migration, document conversion, document handling, labor, storage space, equipment, supplies, and soft costs (Avedon (1994b:28) identifies soft costs as: lost files/documents, low response time, poor monetary control, and insufficient information to make decisions) were identified as the key factors to consider when attempting to determine the actual costs of an imaging solution.

2. What are the major benefits reaped by an effective document conversion project?

Improved access to documents, remote access to information, fewer lost documents, reduced storage costs, reduced duplication costs, improved worker productivity, increased security, improved customer service, disaster recovery capability, reduced filing costs, competitive advantage, and better document output quality were identified as the major benefits to be reaped in an effective imaging application.

3. Which activities/processes are best suited to ADC with regard to return-on-investment and mission effectiveness?

High retrieval-rate documents, historical archives, collaboratively developed documents, high-volume document library, timely access requirements, multimedia documents, high knowledge-content documents, and authenticated documents were identified as applications which were recommended for application of document imaging technology.

Additional Lessons Learned

While the focus of this study was on answering the previously identified research questions, there was additional information provided by the experts in their answers to the open-ended survey questions. While this information is not scientifically founded, it could be quite valuable in that it provides us with lessons learned through actual application of imaging technology.

Of these lessons learned, one of the most prevalent was that of ensuring our document imaging systems are based upon open, standards-based systems. There were several strong references to this by our experts. The general idea here is that reliance upon proprietary software for imaging applications places the user in an often difficult and expensive position when the time to upgrade, expand, or migrate to a new system. By tying ourselves to a proprietary system, we lock our organization into a format or system which may not prove to be our best solution in the long run.

The second most often mentioned lesson learned was that imaging as an end unto itself is not very useful. To be most effective (both cost and mission), document imaging should be implemented as a result of a Business Process Reengineering (BPR) effort. Basically, BPR consists of analyzing our key processes, determining the optimum way to carry out these processes, and then applying appropriate technology (imaging or some other). When document imaging is recommended as a result of an extensive BPR project, the results are most successful. Just applying document imaging to an already existing manual process can be likened to the proverbial "paving the cowpath." Unless the cowpath leads to where we want to go, we've just wasted our efforts.

Another lesson learned by our experts was that document imaging can be a very expensive solution to a problem. When we determine that imaging is the solution to our problem, we must be willing to commit the time, money, and manpower to do it properly. Trying to implement a cheap solution will likely result in wasted efforts.

The final major lesson learned in this research was that, as in any successful information technology project, support by the top management in the organization and the individuals expected to use the system are critical to the overall long-term success of

the project. Lack of user involvement during the requirements definition, system design, and system initiation phases of the project may result in a project destined to a short-lived and expensive death by attrition of use. Not only will this cause us to lose the resources from this project, but it will instill a reticence within senior management and the user community for accepting document imaging technology in the future.

It is the belief of this researcher that application of the information gleaned from our experts' experience can save money, manpower, and time in developing our imaging solutions to our business processes.

Conclusions

This research resulted in some solid, useful information for managers of all types of organizations considering application of document imaging technology to a business problem that manager is facing. This information, when backed with further research by the manager into this topic, will help us to apply imaging technology accurately, efficiently, and effectively. With a focus on proper application of the information proposed in this research, our wasted efforts toward modernizing our office environments should be minimized. We should be able to effectively harness the technology available to us to more efficiently carry out the critical processes necessary for success in a highly competitive atmosphere.

Recommendations and Limitations

The methodology used in this research (document review with expert interview via questionnaire) was primarily chosen and used due to resource constraints of the researcher. This type of research would have benefited by a more rigid method of research which may have provided more statistically relevant analysis of the results of the

survey. One method for conducting research of this type is the Delphi method. Essentially, the Delphi method is a decision making aid which elicits a consensus of judgment or opinion from a panel of experts through an iterative questionnaire and feedback process. This method is very similar to the method used here, but the iterative process enables the experts to examine other experts' opinions about the subject and either modify or remain firm their own opinion. Had the Delphi method been used in this research, it may have resulted in more solid understanding of what our experts opinions were about the various topics covered in the research.

Another limitation experienced in this study was that of a relatively small group of experts providing input to the process. Had there been more experts with a broader range of experience and backgrounds, the results might have been more generalizable in their application. As it was, the group of experts tended to come from a DoD organization and this limits the generalizability of this study's results.

Summary

The overall results of this research provide managers with useful information, which can be applied to the problem of dealing with the profusion of different types of information in our daily operations. It can help us integrate that information in such a manner as to effectively make use of the various forms and strengths of each type of information, both electronic and paper. Due to the qualitative, opinion-oriented nature of this study, I would encourage the reader to examine the data provided by our experts and ensure that your interpretation of the data is consistent with that of the researcher. Additionally, personal examination of the data by the reader quite possibly will result in

identifying information overlooked by this research which may be pertinent to your particular application.

Appendix A: Glossary of Terms

Automated information system (AIS): A combination of information, computer, and telecommunications resources, and other information technology and personnel resources that collect, record, process, store, communicate, retrieve, and display information (NAPA: Appendix A).

Benefits: Outputs or effectiveness expected to be received or achieved over time as a result of implementing an alternative. Monetary benefits are nominally an in-flow of cash, such as revenues. Within the FEA context, monetary benefits are cost savings (see Cost Savings). Benefits can be quantifiable in terms of dollar value or some other measure of productivity, or non-quantifiable as in the case of intangible effects such as increased morale (FEA Guidebook: Appendix A).

Business process reengineering (BPR): A methodology that examines, rethinks, and redesigns mission, products, and services within the political, social, and economic environment of the organization. It seeks to achieve dramatic mission performance gains from multiple perspectives. It is a key part of a process management approach for optimal performance that continually evaluates, adjusts, or removes processes (NAPA: Appendix A).

Effectiveness: An assessment of the qualitative level of achievement of program goals and the intended results, as defined in strategic plans and in legislation(NAPA: Appendix A).

Efficiency: Measure of the relative amount of resources used in performing a given unit of work. Sometimes characterized as doing things right. Can involve unit costing, work measurement (standard time for a task), labor productivity (ratio of outputs to labor inputs), and cycle time (NAPA: Appendix A).

Information: Any knowledge such as facts, data, or opinions, whether numerical, graphic, or narrative and whether written, oral, or maintained in any other medium (NAPA: Appendix A).

Information management (IM): The strategic and operational use of the technologies, dollars, people, services, facilities, policies, and procedures involved in the creation, processing, and transmission of information in accomplishing an organization's activities (NAPA: Appendix A).

Information resources management (IRM): The management of information and related resources, including the planning, budgeting, organizing, directing, training, promoting, controlling, and management activities associated with the collection, creation, use, and dissemination of information (NAPA: Appendix A).

Information system (IS): The organized collection, processing, transmission, and dissemination of information, in accordance with defined procedures, whether automated or manual (NAPA: Appendix A).

Information technology (IT): The hardware and software used to produce information, regardless of the technology involved (NAPA: Appendix A).

Mission performance: The accomplishment of program or agency goals and desired results (NAPA: Appendix A).

Process improvement (PI): An approach to increasing the effectiveness and productivity of an organization by defining and analyzing the major processes with an emphasis on reengineering and/or streamlining these processes to improve mission performance and reduce costs (NAPA: Appendix A).

Tagged Image File Format (TIFF): A standardized format for storing header information about an image.

Appendix B: Survey Questionnaire

20 Oct 96

The Government Performance and Results Act of 1993 requires all government managers to manage for results through the use of strategic planning, and annual assessment and feedback of goal achievement. The growth of a business process reengineering (BPR) culture in the US government is directly related to this mandate by the President. One of the major facilitators of successful BPR projects is the effective use of information technology (IT). While the US government spends millions on IT, it is often without significant results in efficiency or effectiveness.

The US government is lagging behind the civilian market in effectively implementing strategically oriented document imaging and management systems. Applications within government organizations exist which would benefit significantly by proper application of document imaging and retrieval technology. In order to capitalize on these opportunities, Managers need an effective method for determining which applications would be most cost effective and mission impacting.

This purpose of this study is to aid in development of guidelines for document imaging which government managers can effectively apply to this problem. Your participation in this study will result in identifying the major considerations, both tangible and intangible, which should be used in determining appropriate document imaging applications within the US government in general, and the DoD in particular.

Your participation will be limited to responding to this initial questionnaire. There will be no requests for personal or proprietary data. All responses will be completely confidential and anonymous. The research is being conducted as part of my masters degree program at the U.S. Air Force Institute of Technology. The findings will be published as part of a thesis. If you have any questions, please contact me by phone at 937-233-0006, or e-mail at fknaak@afit.af.mil. Thanks in advance for your participation in this study.

Fredrick W. Knaak III, Capt, USAF
Air Force Institute of Technology

Summary

The expected outcome of this exercise is a synthesis of the expert knowledge of the participants into a product which is generally more accurate than any one expert's personal opinion. This method has proven successful in past endeavors for which their is little quantified research. You are requested to provide your expert opinion on the set of questions presented in the questionnaire. The results will be evaluated and used to produce the synthesized expert opinion of the group. The product will hopefully provide managers with the information necessary to evaluate functions which would benefit the most from document imaging and related technology. A unified expert opinion of the factors which contribute to effective economic analysis of potential document imaging applications should also be an outcome of this research.

Responding to the Questionnaire

1. Due to the time limitations of this study, please respond by 1 November, 1996. Your rapid response is tremendously appreciated. In order to facilitate the timeliness of response, this questionnaire is being distributed in an electronic format. If this poses a problem for you, feel free to print out a paper copy and return your response via "snail-mail." Paper responses should be mailed to:

   Captain Fred Knaak
   AFIT/LAA
   2950 'P' St.
   WPAFB, OH 45433-7765

   Electronic responses should be submitted to:

   fknaak@afit.af.mil

   If you have any questions or problems feel free to contact me at either of the previously listed addresses, or via telephone at **937-233-0006**.

2. Many of the questions ask for comment. Your comments are needed to clarify your position with respect to the other respondents to this questionnaire. The answers to all of the questionnaires will be synthesized to produce a range of views on the topic.

3. The final page of the questionnaire is provided for any additional comments you may have relative to the subject. Again, please feel free to provide this information as it may have a significant impact upon the success of this study.

4. Please remember that all responses to this questionnaire are confidential and any identifying information in your responses will be stripped prior to analysis of results. Your individual responses will be destroyed upon completion of this research in November, 1996.

5. Please retain a copy of this questionnaire for your records. This backup copy could help in the instance that transmission of the questionnaire is unsuccessful.

THANK YOU IN ADVANCE FOR YOUR PARTICIPATION

Part I. This section asks for background information. Answers to these questions will provide demographic information about survey participants.

Instructions: Please fill in the blanks or check the appropriate box.

1. What is your current level of knowledge about **document imaging systems** and applications?

☐ None ☐ Minimal ☐ Average ☐ Above Average ☐ Expert

2. What is your current level of knowledge about **information systems/technology**?

☐ None ☐ Minimal ☐ Average ☐ Above Average ☐ Expert

3. What is your current organizational tier?

☐ Technician ☐ Technician/Supervisor ☐ Mid-Level Manager ☐ Senior Manager

4. What type of organization are you currently working for?

☐ Gov. Civilian ☐ Gov. Contractor ☐ Military ☐ Commercial ☐ Other

5. What is your current job title? _____

6. How many years of experience do you have with document imaging systems or applications?

☐ Less than 6 months
☐ At least 6 months but less than 1 year
☐ At least 1 year but less than 2 years
☐ At least 2 years but less than 3 years
☐ At least 3 years but less than 4 years
☐ 4 years or more

7. Please describe your experience as it relates to the area of document imaging technology or systems. For example: "I led the design and implementation of a major imaging system at the organization-wide level. It consisted of over 30 imaging stations and 5 million dollars worth of equipment."

Part II. This section will focus on determining the major **tangible** factors involved in developing a strong business case for a document imaging application.

Instructions:

Please rate the following statements by placing an "X" in the appropriate box.

1 (strongly disagree)
2 (disagree)
3 (neither agree nor disagree)
4 (agree)
5 (strongly agree)

1. Imaging is most valuable to an organization when it is a result of a comprehensive review of business processes.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

2. Successful imaging projects require aggressive support of top organizational leadership, with a willingness to promote change.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

3. Information must be viewed as an extremely valuable corporate resource in order for imaging to reap its greatest benefits.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

4. Imaging is not a one-time investment which results in immediate savings to the organization.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

5. Timely access to information is critical to the continued success of the organization.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

6. A key cost consideration of an imaging project is the savings achieved by decreasing the paper record holdings of the organization.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

7. Appropriate training is important to successful imaging technology implementation.

1☐ 2☐ 3☐ 4☐ 5☐

8. Training is a recurring need with recurring costs which should be incorporated into budgets and long-range plans.

1☐ 2☐ 3☐ 4☐ 5☐

9. A successful imaging project relies upon long-term alliances developed with key vendors in imaging technology.

1☐ 2☐ 3☐ 4☐ 5☐

10. Imaging is most appropriate for documents which are frequently accessed from multiple sites.

1☐ 2☐ 3☐ 4☐ 5☐

11. Imaging is best used for documents in which graphic (as opposed to strictly textual) information is vital.

1☐ 2☐ 3☐ 4☐ 5☐

(Previous statements were extracted and paraphrased from study done by Penn State, Imaging for Process Improvement: Report of the Imaging committee, July 1995.)

12. Document imaging is most effective when it is used as part of a total document management system.

1☐ 2☐ 3☐ 4☐ 5☐

13. Information which is critical to business operations, the loss of which would cause significant resources to recover, is a prime candidate for imaging.

1☐ 2☐ 3☐ 4☐ 5☐

14. The <u>non-quantifiable</u> (e.g. customer service, workflow improvement) benefits of imaging often outweigh the <u>quantifiable</u> (e.g. manpower savings, storage costs) benefits.

1☐ 2☐ 3☐ 4☐ 5☐

15. Decreasing manual storage costs of records is a primary reason to implement document imaging.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

16. Basing an imaging system on an open and standardized system (like TIFF) is a major consideration for the success of an imaging system.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

17. Migration of digital documents to future platforms will constitute a significant portion of imaging costs.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

The following questions are free-flow. Your experience with document imaging should be the foundation for your answers. Try to refrain from answering a question based on something you've read or heard versus actual experience.

18. What are some of the major benefits of an imaging system?

19. What would your advice be to a manager who is considering implementing an imaging system?

20. What areas would you emphasize when developing an economic analysis of an imaging project?

21. What is the likelihood of justifying an imaging application based upon clearly identifiable/quantifiable cost savings

22. What lessons have you learned that you wish you would have known prior to embarking on an imaging project?

23. What are the primary cost factors involved in an automated document conversion project, both tangible and intangible?

24. What are the major benefits reaped by an effective document conversion project?

25. Which activities/processes are best suited to ADC with regard to return-on-investment and mission effectiveness?

26. If faced with cost justifying an imaging application, what would you identify as the major benefits associated with document imaging?

27. Is there anything you want to include in the conclusions of this research?

28. What factors would you use to determine the applicability for using an imaging system?

Would you like a copy of the results of this research for your own use?

Appendix C: Raw Expert Ratings

The following data was the actual responses by the experts to the Likert scale questions. The mean score was calculated using number of valid responses only. Percent agree and percent disagree ratings were determined by combining agree/strongly agree and disagree/strongly disagree ratings and dividing by number of valid responses. Likert ratings were identified as:

1 (strongly disagree)
2 (disagree)
3 (neither agree nor disagree)
4 (agree)
5 (strongly agree)

	Expert Number								Mean	Percent	Percent
	1	2	3	4	5	6	7	8	Score	Agree	Disagree
Question	Likert Scale Rating										
1	3	3	5	5	5	4	5	5	**4.38**	**0.75**	0.00
2	5	3	5	5	5	3	5	4	**4.38**	**0.75**	0.00
3	5	4	5	5	5	2	4	5	**4.38**	**0.88**	0.13
4	5	5	5	5	5	3	5	5	**4.75**	**0.88**	0.00
5	5	4	5	4	5	5	4	4	**4.50**	**1.00**	0.00
6	3	3	4	3	2	1	3	2	2.63	0.13	0.38
7		4	5	3	5	5	4	4	**4.29**	**0.75**	0.00
8		5	4	4	5	4	4	4	**4.29**	**1.00**	0.00
9		3	3	4	3	2	3	4	3.14	0.29	0.14
10		4	3		2	5	4	5	**3.83**	**0.67**	0.17
11		4	1		2	2	4	3	2.67	0.33	0.50
12		4	5	4	5	5	5	4	**4.57**	**1.00**	0.00
13		4	4	4	5	4	4	4	**4.14**	**1.00**	0.00
14	5	5	4	3	3	3	5	4	**4.00**	**0.63**	0.00
15		2	4	3	4	2	2	1	**2.57**	0.29	0.57
16		5	5		4	5	5	4	**4.67**	**1.00**	0.00
17		3	4		3	3	4	5	**3.67**	0.50	0.00

Note 1: Blank responses in expert 1's responses are due to technical problem retrieving survey results. Blank responses in expert 4's responses were not answered by the expert, presumably due to technical problems again.

Note 2: Bold entries indicate consensus of agreement/disagreement of the experts was reached by mean Likert rating above 3.4 or below 2.6 or percent agree/disagree above 60 percent.

Appendix D: Open-Ended Question Responses

The following entries are the actual responses by the experts to the open-ended questions in the survey:

Expert 1:

18. Compression and rapid retrieval.
19. Determine exactly the desired solution—then tailor your requirement.
20. Scale of document collection and volume of documents generated on a daily basis.
21. It is wholly possible, but the ultimate justification is compression and speed of information retrieval.
22. Automatic indexing
23. Hardware, software, scan stations, document manager
24. Rapid access to information, compression
25. Rapid access
26. Reduces need for file clerks, compression, and retrieval
27. No

Expert 2:

18. Saves space, provides more rapid access to the documents (in some cases, at least), helps to preserve historically significant information, can produce a copy (paper or electronic) that is better than the original.
19. Think the whole process through before you do anything. Be sure you buy an open rather than a proprietary system. Recognize up-front that even the fanciest system will not magically solve all your document storage and retrieval problems—you'll probably find new, high-tech ways to lose track of the documents.
20. Economic factors were not a key issue when we bought our original system, nor were they a major factor when we replaced it, so I have little experience with this kind of economic analysis.
21. Cost savings were not a factor when we justified our original system.
22. The value of open (rather than proprietary) systems. That is the single most important lesson I learned.
23. I have found that the cost of maintenance and upgrades (hardware and software) are far more substantial than I assumed they would be. I have also learned that it is very difficult to justify an imaging system based on potential cost savings, at least in my experience. I have had much better luck using the "preservation" argument.
24. Cost savings notwithstanding, you can, in fact, save space. You can preserve data more effectively. You can, if your indexing process is effective, retrieve information more quickly. You can make multiple copies of your information and store them in different places.
25. From my perspective, archival management is a natural for ADC. I have no experience with other activities and processes.

26. preservation, retrieval, and security (backups).
27. Open systems are a must. Proprietary systems can become an expensive dead-end. This probably cannot be stated often enough.
28. Basically the same factors I mentioned in response to question 26: do you have information or documents you need to preserve and retrieve on an infrequent basis (the documents we tend to use most frequently have not yet been converted to digital format because we need to ensure we have processes in place that enable us to retrieve the digital information as fast as we can the paper copy).

Expert 3:

18. Compact, efficient storage of documents in longer-lasting format than paper copies; easier to retrieve documents rapidly; alleviates expenditure of resources on refiling of hardcopy documents.
19. Define carefully what your requirements are, then research thoroughly what systems are available (across the entire price range) to meet those requirements.
20. Initial procurement; maintenance over life cycle, including potential upgrades or expansion of the system.
21. Less than 50 percent.
22. Beware of vendors who minimize proprietary nature of software associated with systems.
23. High manpower investment to prepare documents for scanning , which takes personnel away from other important tasks; temporary loss of access to documents being converted.
24. More efficient access to documents.
25. Archiving of historical documents for subsequent retrieval in response to research requests.
26. Reduction of storage space and costs, as well as much improved responsiveness to requests for information.
27. Document imaging is essential to efficient storage and retrieval of rapidly increasing quantities of information.
28. Type of material, relative costs of storage by other means, how often information is requested, who is most likely to need the documentation in the future.

Expert 4:

18. Faster access, structured workflow
19. Do not become enamored with the technology; focus on improving your business process, then we will apply the proper technical solution.
20. Acquisition and out year costs versus status quo and out year costs
21. Very good
22. Senior level involvement is essential
23. Acquisition (services, hardware, software) and out year operations, maintenance, and upgrades
24. Rapid access to organized information, disaster recovery capability

25. Assembly-line operations with structured processes
26. Reduced manpower for manual tasks, reduced office space/storage services
27. This technology is not cheap to acquire of support. If you are planning to go on the cheap, don't start!
28. No comment - lack of current information to answer at this time

Expert 5:

18. Allows the sharing of information electronically, rather than in paper, also cuts down on losses from filing paper copies.
19. Know all processes from top to bottom and get employee feedback and involvement.
20. Cost of replacing lost paper copies due to lost paper, misfiles and laziness. Stay away from the business of benefits gained from doing away with file cabinets.
21. Possible, but don't overlook the human buy-in. If people don't want it they won't use it and they will always resent it.
22. Get the users involved from the get-go and keep them involved. Don't try to know it all, be prepared for the dumbest question to turn out as the best question and solution.
23. Cost of scanning. Start from a date and go forward. Don't try to back-scan old stuff that is rarely accessed.
24. Sharing of information easier and more effectively. Finding information quicker and easier is an area of pay back often overlooked.
25. ????
26. Mentioned previously.
27. Document imaging still has a position, but why not center on managing information electronically to begin with. There is not a great demand to scan and save something that cannot be found in its digital format to start with. I would put my eggs into the electronic records management (ERM) basket rather than straight document imaging.

Expert 6:

18. Increase availability of information; allow greater replication and protection of information; facilitate dissemination of information using electronic media.
19. Imaging is "poor man's workflow." If you have a choice between imaging an end product and redesigning the business process to produce electronic output, you will generally reap greater long-term benefits by redesigning the process. Unless your process involves imaging 100,000+ documents per day, imaging will not be cost-effective as your primary means of data input.
20. How often do people need documents, and how many people need them? Frequency of retrieval and need for mass distribution/access are the key indicators.
21. Excellent, considering how many have been justified for less useful reasons.
22. Most of my experience with imaging has been cleaning up after other people and providing "lessons learned." The best lesson so far is: people need to understand what imaging can and can not do for them before they invest. Too many people spent money without knowing precisely where they were to going to get return on their investment.

23. Labor and equipment. If you use your own people, double the man-hour costs, as time spent imaging documents is time away from the work they're supposed to be doing.
24. Greater access via computer-mediation to information repositories. Better able to replicate, preserve, and back-up information. Potentially better information flow via computer mediation.
25. Any process or activity with a high (more than 100,000 pages or more per day) paper output where extensive use may be made of the information. (By ADC, I'm assuming you intend this as an ongoing business activity and not just a one-time project.)
26. Increase availability of information; allows greater replication and protection of information; facilitates and reduces costs of dissemination of information using electronic media. (This looks an awful lot like Q18.)
27. Document imaging has its uses, but a properly designed computer-mediated system will be much better in the long run.
28. Can I redesign the business process to produce paper instead of digital? If not, is the volume of paper information and frequency of retrieval high enough to warrant installing an imaging system.

Expert 7:

18. Improved collection, organization, preservation and dissemination of information; improved access (speed, remote, local), portability of information (copy, print, fax, electronic transfer.)
19. To me the key thing to remember is that an imaging system is not a panacea for all information management woes. It requires a large investment (capital and labor) and continuing operating expenses. If the current system does not work and you simply automate, chances are the new system will experience similar problems.
20. Improved access to information; conversion costs; indexing costs; lifecycle costs. If speed of access is not a key consideration, space for storing paper records is still cheaper than any automated system! If backfile conversions are involved, don't forget to include the cost of preparing and converting large volumes of paper. This can be very time consuming and cost more than the investment in hardware and software. During implementation and until the conversion is complete, a dual system will probably be required. What level of indexing (the second most overlooked workload) is required (how much information is needed to find the right record at the right time.) Archiving and disaster planning, data migration to next generation of technology, the list goes on!
21. In my opinion, slim, but it's great if you can measure the cost savings associated with improved access, decreased storage costs, etc. If there is no penalty for delaying information delivery what cost offset can you apply?
22. Document imaging systems are not as capable as most vendors claim, indexing is still the key to rapid retrieval and document preparation and scanning is labor intensive.

23. Value of improved access, cost of conversion, document preparation, indexing, lifecycle costs.
24. Improved access, transportability, intellectual control of information if converted to text (OCR) and full-text indexed.
25. Applications where speed of access and document control are important.
26. Improving access to information, Improving the collection, organization, preservation and dissemination of information. "The right information, at the right time and place to support all business processes." Decreasing the overhead (personnel, storage space, reliance on printed copies, etc.) of managing paper-based information in a manual system of records.
27. I believe document imaging is a component of an effective records management system. The real benefits are realized when documents are created, circulated, protected, and archived in electronic form and are only printed when absolutely necessary. The ideal is a cradle-to-grave records management system which complies with all aspects of information management including security classification.
28. Factor #1: What's wrong with the current process? #2: Will an imaging system improve the process? #3: Compatibility and interoperability, who needs access to the information. How will access be provided? #4: What records management policies apply and how will the system comply? #5: What is the total cost? (Total costs including conversion, operating and lifecycle costs)

Expert 8:

18. Rapid retrieval, concurrent access to high demand, high value records, significant process improvement
19. First consider business process reengineering. Analyze and determine what is the problem. Organize and form a project team with your best talent/key players. Scope the problem and consider many alternatives. Document imaging is just one of many technologies to manage information—generally speaking document, imaging is the more expensive and the more risky solution. I have personally seen systems procured and not even used after the "driver" left the organization.
20. What are the costs of doing business today? What are the costs of doing business with the proposed system? Do not recommend using FASCAP to justify imaging systems—you will need the same or more personnel to manage the proposed system.
21. Slim to none. Document imaging systems will not cost justify solely on storage and retrieval, space savings, etc. Clearly, there must be some process improvement, business advantage, or solution to a problem that warrants the investment.
22. None, I have only been involved in a few acquisitions.
23. I have not prepared a cost-benefit analysis so I will defer this question to an article I am sending you which addresses this issue in detail.
24. Same as 23 above.
25. Can't honestly answer this question. See article previously referenced.
26. Defer this question to article also.
27. N/A

28. Probably the most significant factor is the perceived value of the record collection considered for imaging. Are the records accessed often, is there value added in fast retrieval, does it have a reasonable retention period (you wouldn't image transitory information). Is there an expected cost reduction or significant business advantage to be gained?

HEADQUARTERS UNITED STATES AIR FORCE RESERVE

DIRECTORATE OF INFORMATION MANAGEMENT

RECORDS MANAGEMENT COST ANALYSIS METHODOLOGY

AND

DOCUMENT IMAGING METRIC

HQ AFRES/IM
7 June 1994HQ AFRES/IM
RECORDS MANAGEMENT COST ANALYSIS METHODOLOGY
AND DOCUMENT IMAGING METRIC

Table of Contents

1. Introduction

This paper will explain the HQ AFRES/IM records management operational cost analysis and metric for document imaging.

The traditional metric for document imaging has been the cubic feet of records eliminated. Cost justification for document imaging is usually based on a combination of cubic foot reduction and reducing a theoretical amount of lost records in a given record series.

However, assigning a fixed value to either of these factors and attempting to extrapolate costs that apply universally to all records does not take into account the actual operational costs of using the records. Simply imaging 10,000 cubic feet of records may result in little actual cost benefit if those records are rarely used. Also, estimating a fixed cost for lost records based simply on the size of a record series does not account for the frequency of use, number of transactions performed on the records, level of expertise of the people handling the records, or other factors that affect the probability that a record will be lost or mishandled. These costs cannot be accurately generalized for all record series.

Therefore, we have developed a prototype functional analysis methodology that serves three purposes:

1. It will help identify the annual costs of various record series.

2. It will help identify record series that are good candidates for changes in the way they are maintained and a way to prioritize them.

3. It will provide a means of measuring the effectiveness of changes in records management, including document imaging projects.

For the purpose of this metric, records are defined as:

> "...all books papers, maps, photographs, machine readable materials, or other documentary materials regardless of physical form or characteristics, made or received by an agency of the United States government under Federal Law or in connection with the transaction of public business and preserved or appropriate for preservation by that agency or its legitimate successor as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities of the Government or because of the informational value of data in them. (Federal Records Act)."

A record series is: "A group of records or other record media relating to the same subject and identified with a particular table and rule." (AFR 4-34, 10 November 1989.) The assumption is that not all record series incur the same relative costs for maintenance and use, and that there is a viable means of comparing these costs. In addition, active files

and inactive files in a record series will have different costs associated with them and should be evaluated separately.

As different organizations may use similar record series in different ways or with different frequency, we recommend calculating costs at the lowest practical level of use. Assessments of individual record series should be conducted by individual offices of record..

Variables

The main variables used in this analysis are: frequency of use, records management activity costs, normal retrieval time, out-of-cycle (emergency) retrieval time, risk of loss or damage, and the size of the series. These variables will be explained in more detail in Section 2.

Once a record series has been scored, you then try to find ways to reduce costs through process and procedural changes. This may involve anything from changing the way records are handled to introducing a radically new system with enabling technology. A projection is made of the costs of the new system versus the old, which should show some of the benefit of the proposed change. If it appears that the new system will be significantly better than the current one, you may decide to implement the change or conduct a more detailed cost benefit analysis. This will be described in greater detail in Section 3.

Section 2, Functional Analysis, will describe the criteria used to score record series.

Section 3, Application, will describe how we intend to validate and apply this method.

Section 4, Access Ratios, will describe an additional metric that illustrates the amount of direct access users have to information. This metric may be used to provide additional justification for reengineering records management practices.

2. Functional Analysis

This method calculates the operational cost of record series (**C**) based on five primary variables:

The annual cost of a record series: (T)

The total annual process cost of a record series: (P)

Out-of-cycle access cost modifier: (A)

Risk factors associated with the record series: (R)

Amount of space occupied by the record series: (S)

Each of these variables is derived from a combination of secondary variables:

Frequency of use: (f)

Average cost for an individual activity: (t)

The average creation process cost: (p_c)

The average operational process cost: (p_o)

The average periodic maintenance process cost: (p_m)

Average labor cost for the people handling records: (l)

Average number of minutes for an activity: (m)

Normal access time for a retrieval: (a)

Out-of-cycle access time for a retrieval: (c)

Percentage of normal retrievals: (n)

Percentage of out-of-cycle retrievals: (e)

Each of these variables and how they affect the cost analysis will be explained in the following sub-sections.

Activities

An activity is any action involved with a record. This includes creating, indexing, filing, retrieving, routing, copying (all or part), or disposing of a record. This does not include reading or otherwise extracting information from the record, as those are value-added activities, not an overhead.

One note on figuring activity: if a record is routinely duplicated after retrieval by use by more than one person at the same time, the transaction count should include *all* actions performed on *every* copy of the record from that point.

The following is a list of standard activities associated with managing Federal records:

Creating a record
Filing a record
Locating and retrieving a record
Duplicating a record
Transmitting (mailing, shipping, hand-carrying, etc.) a record
Retention schedule maintenance (destruction or archiving)
Conversion to a different media (scanning, re-keying, etc.)
Index maintenance
Inventory/audit records

Activity Costs

Calculating activity costs can be a complex operation. For the purpose of this metric, we will use a simple activity cost model that may be employed by anyone with a basic knowledge of mathematics. In addition, there is a spreadsheet available that will automatically perform all of the calculations described in this methodology. Information may be collected for the spreadsheet using the questionnaire in Appendix A.

The first step is to determine the average hourly salary of the people involved with each activity. For the purposes of this document, we will assume the average hourly salary for the people who work with our records is $15 per hour. In a real organization, you would obtain this cost from actual salary information.

The activity cost formula for this metric is a simple estimation based on labor costs. There are more complex ways of estimating activity costs, but this formula is sufficient for our immediate needs. Activity costs are figured as the number of minutes an activity takes times the hourly wage divided by 60:

$$t = (m)(l)/60$$

This will produce a simple activity cost. Other factors commonly found in activity cost analysis are included in the application of this method described in Section 3.

As we wish to keep this model simple, there is no need to estimate the exact cost every time an activity is performed. For the purpose of this metric, use the average number of times a particular activity is normally performed as part of the process.

The number of activities per retrieval (**t**) multiplied by the average transaction cost becomes the process (**p**) cost for a single retrieval from a record series.

Process Costs

A *process*, for the purpose of this metric, is a collection of activities with a discernible beginning and end. The process cost, therefore, is the sum of the activity costs that comprise the process.

For records management operation costs, the process could begin with the creation of a record and end with its eventual destruction. However, that is too broad a process to measure accurately. Therefore, we divide the life cycle of records management into three general process areas: creation, operations, and maintenance.

Creation Costs

The process and costs of creating record material will vary greatly from individual to individual depending on the media. Some people fill out forms faster with a pen, others will be faster typing at a computer.

Given the large number of variables involved in the creation of records, costs for this activity should be calculated using the same input. Select a representative sample of at least five record types that exist in both paper and electronic format, and time how long it takes to fill in and store the forms, letters, etc. You should include any time needed for correcting errors and indexing new records.

For forms that are stored on paper, this will involve filling in a form, typing a letter, etc., making whatever annotations are necessary for indexing and filing, and depositing the form in the appropriate filing cabinet. You may wish to distinguish between using a pen, a typewriter, or computer-generated forms that produce paper output.

Cost for microfiche, microfilm, electronic, and other records stored in machine-readable format should include the time spent filling in input forms and any conversion from other media. For example, if users fill in a paper form which is then scanned into a digital format, you count the time spent filling in the paper form and the time spent using the scanner and indexing the new record.

Example: we have a hypothetical record series where we create 20 records each week. If we estimate that it takes us an average of four minutes to create, one minute to annotate (index), and one minute to file each record:

create	= 4(15)/60	= $1.00
annotate	= 1(15)/60	= .25
file	= 1(15)/60	= .25

At $15 per hour, this give us a creation process cost of $1.50. If we create 1,040 records per year, this gives us an estimated annual creation cost ($\mathbf{p_c}$) of $1,560.

Operational Costs

For this exercise, we will assume that locating a record in an index takes an average of 1 minute, physically retrieving it takes another minute, copying it takes 1 minute, and mailing the copy (including preparation) takes 2 minutes. Also, since they must return the original record to the files, we will add another minute for that activity.

For the five activities listed above, this translates to:

locate	= 1(15)/60	= .25
retrieve	= 1(15)/60	= .25
copy	= 1(15)/60	= .25
mail	= 2(15)/60	= .50
refile	= 1(15)/60	= .25

The operational process cost ($\mathbf{p_o}$) is $1.50. The cost changes if you produce more than one copy, however. If, however, we routinely make eight copies, we should now multiply the cost for copying and mailing the extra copies of the record:

copy	= 8(15)/60	= 2.00
mail	= 16(15)/60	= 4.00

Now the operational process cost ($\mathbf{p_o}$) is $6.75.

Using this process cost, we may now calculate the estimated annual costs to the organization for those activities. Assuming 50 retrievals a week over 52 weeks, with an average of 1 copy per retrieval, the first example's annual operating cost is:

$$\mathbf{p_o = 2{,}600(\$1.25) = \$3{,}900}$$

In the second case, assuming the same number of retrievals, the extra copies raise the cost:

$$\mathbf{p_o = 2{,}600(\$6.75) = \$17{,}550}$$

Maintenance Costs

The final process cost area is periodic maintenance. This cost reflects the administrative overhead associated with the record series.

Maintenance activities are usually performed periodically, instead of continuously, and may only deal with a portion of the total record series at any given time. Instead of calculating a specific activity cost and extrapolating, you may calculate annual maintenance costs by either counting or estimating the number of hours spent per year auditing records and multiply the total hours by the hourly wage.

For the sample record series, we will assume that we spend 4 hours every quarter, or 16 hours per year auditing the series:

$$\mathbf{p_m = 16(\$15) = \$240}$$

Total Annual Process Cost

The total annual process cost is the sum of the creation, operational, and maintenance costs. For the first example, this is:

$$\mathbf{P = p_c + p_o + p_m}$$
$$\mathbf{P = \$1{,}560 + \$3{,}900 + \$240}$$
$$\mathbf{P = \$5{,}700}$$

For the second example, P equals:

$$\mathbf{P = p_c + p_o + p_m}$$
$$\mathbf{P = \$1{,}560 + \$17{,}550 + \$240}$$
$$\mathbf{P = \$19{,}350}$$

In the next step, this basic cost is modified by out-of-cycle access considerations.

Out-of-Cycle Access Costs: Normal Time vs. Criticality

There are cases where records are required in less time than the normal retrieval system can deliver them. In such cases, additional resources are usually committed to expedite retrieval of those records, with a corresponding increase in cost for each such retrieval. In addition, there is no guarantee that committing additional resources will ensure retrieval in the time required, so there may also be a cost associated with the failure to retrieve needed information. These costs fall outside the normal access cycle for records, and are referred to as "out-of-cycle access costs."

The out-of-cycle access cost modifier is applied to the total process cost, not just operational costs. Emergency response may involve creation of new records and impose an additional burden on maintenance of records, all at a higher than normal cost.

Out-of-cycle access costs are exceptions to the rule and do not generally make up a large portion of normal access to records. The out-of-cycle access cost modifier (**A**) is based on two factors: the normal cycle time for a record retrieval and how fast someone may need access to a record in an emergency.

The normal access time variable (**a**) is based on the normal access time for someone who needs the record. This should be the normal retrieval cycle for a record, not the fastest time a record could be retrieved if extra energy were expended and is calculated from the time someone decides they need a particular record to the time they actually have it. The time it takes to access a record is usually based on the distance or barriers someone must cross to reach it (or that the record must cross to reach the person), and the difficulty involved in finding specific information in the record.

If a record is at or near a person's desk, they will generally be able to find it within two minutes. If within walking distance, it can be retrieved within two hours. Records that are requested and retrieved based on an appointment system, like medical records or, will normally take a about a day to cycle through their system from request to access.

Also, when a paper record is in use it is not normally available to anyone else who may want to look at it. This calculation should include the total time a record is checked out for paper records, not just retrieval time, to simulate the potential costs of non-availability. Access time is defined by the following criteria:

Very Low: A couple minutes. (**a = 1**)

Low: Within two hours. (**a = 2**)

Medium: Within a working day (8 hours). (**a = 3**)

High: Within two days. (**a = 4**)

This methodology is not designed to measure costs for record management systems with retrieval times in excess of two days. It can be argued that any local system where records cannot be accessed within two working days is automatically good candidate for process reengineering.

Criticality (**c**) is how fast someone might need to meet a short suspense or an emergency with the information. This is based on the potential value of the information if obtained within the required time.

Very High: You need the record within a couple of minutes. **(c = 1)**

High: You need the record within two hours. **(c = 2)**

Medium: You need the record within a working day (8 hours). **(c = 3)**

Examples of information with high or very high criticality would be medical records or intelligence information, as opposed to those with a slower normal cycle time like inventory records.

Using these factors, access cost for out-of-cycle retrievals (**A**) is produced by the following calculation:

$$A = a/c$$

Sample calculation: Using our hypothetical example above, we assume that the records are normally retrieved to meet a one working day suspense. This gives the normal access variable **a** a value of 3. However, someone decides they need a copy of a record from that series within an hour, giving the criticality variable **c** a value of 2.

$$A = a/c = 3/2 = 1.5 \text{ times normal cost per retrieval}$$

The cost associated with time and criticality is higher because of the energy expended in retrieving the records to meet a much shorter suspense than normal. This is, again, a conservative estimate of the out-of-cycle access costs. It also does not take into account the cost if information is not retrieved in the time needed. If a records management system cannot meet true emergencies, even for only a small percentage of its retrievals, serious consideration should be given to reengineering the entire process regardless of the cost estimates. This is particularly true for records which contain "life and limb" type information.

If the records from the example above were routinely available within an hour, the score for this pair of variables would be:

$$A = a/c = 2/2 = 1 \text{ (No modification)}$$

Out-of-cycle access should only be calculated when normal access time (**a**) is greater than criticality (**c**). If you can normally retrieve information as fast or faster than you need it, then no request should be an emergency.

Calculating the Impact of Out-of-Cycle Access Cost

Having calculated the out-of-cycle cost modifier, you then apply it to the percentage of retrievals that were emergency requirements. Let us assume that 5 percent of the 2,500 retrievals per year were emergencies, or 125.

Factoring in the out-of-cycle access modifier, the basic formula for calculating total annual cost (**P**) now looks like this:

$$P = n(B) + e(A)(B)$$

The variable **n** is the percentage of normal accesses and the variable **e** is the percentage of emergency accesses. With the numbers inserted into the variables, where **n** = 95 percent and **e** = 5 percent, the calculation for the sample record series with a hypothetical annual basic cost of $3,750 looks like this:

P = .95($5,700) + .05(1.5)($5,700)
P = $$5,415.00 + $427.50
P = $5,842.50

If, however, we use the process cost for the second example above, where we make all the extra copies, the annual basic cost calculation looks like this:

P = .95($19,350) + .05(1.5)($19,350)
P = $18,382.50 + $1,451.25
P = $19,833.75

Risk Analysis

The next factor used to calculate the cost of maintaining a record series: risk. Analyzing risk for a record series depends in large part on the perception of the people who physically maintain those records. Deriving the risk variable (**R**) will be generally based on an assessment of physical vulnerability that includes the probability of tampering, sabotage, theft, natural disaster and mishandling, and how difficult or expensive it is to replace or recreate records.

The difference between high and very high risk could be the difference between records stored in a high hurricane risk area, and those with a hurricane bearing down on them. Risk for aircraft maintenance records at a forward operating location may depend on how

close enemy troops are to the base. In addition, there is frequently no way to predict disasters like fires, plane crashes, broken water mains, floods, and earthquakes. And even with backup, local users may temporarily incur additional time and distance costs to retrieve and use the backup records if the primary records are destroyed. The risk level associated with records is outlined by the following paired criteria:

Very Low Risk: Secure, easily duplicated, and off-site backup; probability of less than 2 percent errors or lost records per year.

Low Risk: Safe so far, with some backup; probability of less than 5 percent errors or lost records per year.

Medium Risk: May be at risk, little duplication or backup; possibility of up to 10 percent errors or lost records per year.

High Risk: At risk, no backup; possibility of up to 20 percent errors or loss in a year.

Very High Risk: At extreme risk, no backup; probability of error or loss rate in excess of 20 percent per year.

The risk variable (**R**) should be based on the cost of replacing half the highest probable loss of records. Replacement costs should be estimated by those in the office of record who can best calculate the cost of replacing a record. Replacement costs should include, but are not limited to, labor costs, cost of reproducing documents from other sources, and any intrinsic value of the information in the lost record.

For example, we will assume our hypothetical set of records has been determined at low risk and replacing a single lost record has been estimated at $300. If there are 5,000 records in the series, 10 percent of those would be 500, with a total replacement value of $150,000. Half of $150,000 is $75,000, which represent half the probable loss (5 percent).

However, this does not become an actual cost unless records are actually lost, destroyed, stolen, or tampered with. Therefore, we only count 10 percent of the risk cost as an actual cost in the annual cost of maintaining a record set. For the records described above, this would mean adding $7,500 to the total annual cost of the records, or R = $7,500.

Size

The last variable in calculating the cost of maintaining a record series is size (S). This variable reflects the cost of the amount of space records occupy, either physically in paper or digitally on magnetic or optical media, and the cost of the equipment used to store them.

Based on calculations made by the National Archives in 1992, storing paper records costs us $21.19 per cubic foot of paper records per year. Calculating the cubic footage of records in a series is based on the physical size of document in the filing cabinet:

Letter size	linear feet(.8) = cubic feet
Letter size drawer (full)	1.5 cubic feet
Letter size cabinet, 4 drawer	6 cubic feet

A more complete listing of size conversion is in Appendix B, which also includes cost data for electronic storage media and microfiche.

If our hypothetical record series with 5,000 records occupies 35 cubic feet of space, our space cost for this series is **$741.65**.

The Final Formula

The final formula for calculating the total annual costs of a record series within an organization is:

$$\mathbf{T = n(B) + e(A)(B) + R + S}$$

In review, this formula, calculates the operating costs of maintaining and using a record series based on how often a series is used, how costly it is to handle the information, disconnects between how fast we can normally retrieve information versus how fast we might need information in an emergency, what it costs us to ensure the reliability of the information, and the physical size of the series. If we plug in all the variables we've calculated for the first of our hypothetical examples, we get:

T = .95($5,700) + .05(1.5)($5,700) + $3,750 + $741.65
T = $5,415.00 + $427.50 +3,750 +741.65
T = $10,334.15

And, for the example where we routinely make eight copies of a record for every retrieval:

T = .95($19,350) + .05(1.5)($19,350) + $7,500 + $741.65
T = $18,382.50 + $1,451.25 + 3,750 + 741.65

T = $24,325.40

The overall effect of making eight copies during normal retrieval of a record drove the overall cost of maintaining the record series to more than twice its normal cost. In the next section, we will discuss how process improvement with enabling technology may reduce these costs.

3. Application

Once a record series has been evaluated for cost, the next step is to try and reduce that cost as much as possible. This may be done through either process or procedural change. Process change involves changing how records are handled. Procedural change involves changing the rules governing how records are handled. A combination of the two will usually yield the best results.

Justifying Change

Justifying changes in records management processes or procedures based on the relative cost score involves four steps:

1. Conduct the initial analysis of a record series.

2. Predict what changes will occur in the variables if you change a process or procedure.

3. Compute an estimated cost for the record series based on the changes.

4. Multiply the estimated annual operating costs by the number of years within which you expect payback and then add the fixed cost of upgrading to the new system. Subtract this from three times the original operating cost.

For example: The hypothetical record series we calculated in the last section, without the extra copying, shows an annual cost of $13,868.90 on the first run of the analysis. By theorizing certain changes based on new technology and rules for handling these records, you predict you can reduce that cost.

Let's assume that all the records are stored in electronic files on a local area network instead of paper files. Thanks to computerized search and retrieval, it now takes us only 30 seconds to both locate and retrieve a record. And, since everything is electronic, we no longer have to physically photocopy the record and pack the copy into an envelope. Instead, we either attach it to an e-mail or use document routing software. We'll assume this takes 90 seconds, including typing the e-mail cover note. Our process now takes a total of two minutes, with a process cost (based solely on labor, at this point,) of 50 cents. This is 1/3 the original process cost.

To keep the comparison consistent, we still assume 2,500 retrievals per year. This gives us an annual basic cost of $1,250.

In addition, since we now have a fairly stable, secure environment for our records, with regular backup to tape or optical media, the risk factor drops to Very Low. This reduces our risk cost to approximately $3,750.

And finally, as we have eliminated the filing cabinets, we have saved all $741.65 in space they used to represent. If we recalculate our process costs with these numbers, we get:

T = ..95($1,250) + .05(1.5)($1,250) + $3,750 + $0
T = $1,187.50 + $93.75 +3,750
T = $5,031.25

This is $8,837.65 less than the $12,084.90 we estimated to operate with these records in paper. If you expect to pay back your investment within three years, for example, you should not spend more than $26,500 for the new system.

For the example where we routinely produce eight copies for the retrieval, the improvement is much greater. Since sending a single e-mail with a file attached is no more difficult than sending it to a single recipient. Even if we add a full minute for taking longer to address the letter, the basic process cost is still only 75 cents, giving us an annual basic cost of $1,875. We may also safely assume the same savings in risk and size.

Based on that, our new costs are now:

T = ..95($1,875) + .05(1.5)($1,875) + $3,750 + $0
T = $1,781.25 + $140.63 +3,750
T = $5,671.88

This is $21,957.65 less expensive than the old annual cost. If you expect a payback within three years, you should not spend more than $65,800.

If the fixed investment cost of the proposed change does not exceed three times this amount, this record series should be a good candidate for change, as you should make back your initial investment within three years.

On the other hand, reducing a record series' score from $10,000 to $9,000 does not indicate more than a marginal improvement in total cost. Unless the proposed change is relatively inexpensive, less than $3,000 in this case, it will probably not be worth the expense.

Also, the costs of changes may be distributed over more than one record series. Individually, any given series may not show enough estimated cost savings to justify change. However, applying similar change to more than one record series and combining the costs savings may show sufficient cost justification to proceed.

Leveraging Solutions

Let's examine our new system in a different light. If we assume that one solution will work for both our examples, we may add the projected savings for both costs:

$26512.95 + $65872.95 = 92,385.90

Applying the same process change to more than one record series allows you to invest more in the new system with a better chance at paying back your investment in less time.

Investment Costs

When a potential solution has been identified, you must account for the costs associated with implementing it. These costs include, but are not limited to:

New hardware and software
Data conversion costs
Training costs

New hardware and software, including upgrades to existing systems, are fairly easy to document. These are fixed costs and generally represent a one-time capital investment.

Data conversion costs for paper to digital conversion can be substantial. Let us assume we have two clerks who work for $15 dollars per hour, 120,000 pages to scan and index, and the average record size is 24 pages. If we buy a high-speed scanning system, it takes each clerk an average of 4 minutes to scan and index one record, then each clerk can scan and index 360 pages an hour, giving us a total of 720 pages per hour for both. The entire job should take approximately 167 hours and cost us $5000 in labor alone.

However, if these clerks are regular employees, we should increase that amount by at least 50% to reflect the fact that they did not perform their normal duties while scanning in all those pages. This additional costs represents lost productivity. Either their regular work did not get done, or someone else had to do it for them. That cost was redistributed throughout the organization. This brings the combined labor and lost productivity cost up to $7,500.

If we spend less money for a slower scanner, or if we impose a more complicated indexing scheme that requires more manual input, our conversion costs will rise. If the clerks can only scan and index a record every 6 minutes, this raises the labor cost to $7,500. And, if we are using regular employees for this task, the combined labor and lost productivity cost will be at least $11,250.

Training is a one-time investment that may also pay long-term benefits. Good training can significantly reduce error rates and increase productivity with a new system. Some

estimate should be made of the effects of training over the life of the system, particularly as to how training will affect the time need to perform activities.

Investment costs should be considered in relation to each other when developing solutions. Greater initial investment in more capable technology and training may result in significantly lower labor or lost productivity costs both during data conversion and for the new system after implementation.

Metric Development

Developing a metric from the record series analysis is similar to the cost justification, except that after change is implemented you must measure the actual costs of the new system. There are two reasons to do this:

First, hidden costs associated with any new system will affect the organization whether or not anyone publicly admits they exist. Pretending that they do not exist will not make them go away.

Second, a valid comparison between estimates and actual results will provide a basis for making better cost estimates for future initiatives. Knowing that previous estimates were significantly over or under actual results can be of great benefit when allocating resources for new projects.

This will give you an indication of how reliable your initial cost savings estimates were. This information, in turn, should be used to refine your cost justification process. We recommend computing this comparison at least a month, and preferably 3-6 months, after the new system is completely implemented to give users and customers time to adjust. Score the new record series management process as you did the original one and compare the new actual costs to the original. You then subtract the cost score for the new procedure from the old cost. This should show the cost savings from implementing new processes or procedures.

One other factor to consider is any difference in annual maintenance costs for the equipment (filing cabinets, computers, etc.) used to store records. As these are generally dispersed across all record series, they should be figured in when comparing total costs for all record series involved in the change.

Organizational Record Management Metric

It is theoretically possible to determine a relative cost for managing records throughout an entire organization by adding the costs for each record series in the organization. This will show a total records management cost for the entire organization, but would require a 100 percent assessment of all records in an organization.

Once you have a total score, every improvement in individual record series is subtracted from the total. While it is impossible to completely eliminate records management costs as long as you are required to maintain records, some target should be set for reducing them, e.g. 20 percent annually.

4. Access Ratios

Another way of calculating the respective value of records management systems may be by the amount of access they provide to users. This is calculated by dividing the number of total users for a record series by the number of access points to that series.

Access points are the number of places a customer may retrieve information from a given information base. If the information is in paper form, then the number of access points will be equal to the number of copies of the paper document. If the information is in machine-readable form, then the number of access points will be equal to the number of customers who may simultaneously access one machine-readable copy of the document times the number of copies of the document on that media.

Machine-readable formats include microfilm, microfiche, and digital media such as CD-ROM or computer hard drive. An additional consideration when employing these media is that these technologies may place a barrier between untrained customers and their information.

Here is a simple example of calculating access points:

An organization keeps a particular record series stored in paper files, with 50 percent duplication of individual records throughout the organization. This gives us 1.5 access points for this record series.

This hypothetical record series is accessed by approximately 120 people. Dividing 120 by 1.5 gives us an access ratio of 80:1, or 80 users per access point.

If we image this record series, store it on the LAN, and give everyone desktop access through their personal computer, the number of access points now equals the number of personal computers connected to the LAN. If our hypothetical organization has 80 personal computers with network connections, this reduces the access ratio to 3:2. (120/80)

If more than one records management reengineering option appears to be of relatively equal cost benefit, this method may be used as a tie-breaker if concurrent access is important to the organization or of benefit based on the information involved. For information that may be required simultaneously in more than two places at once, access ratio should definitely be considered.

APPENDIX A: Record Series Questionnaire

Unit of Assignment: _____

Functional Address Symbol: _____

Record Series: _____

Active or Inactive Records? _____

Please answer the following questions about your record series:

1. Approximately how many records in the series? _____

2. What is the average gross salary of records management staff? _____

3. An *activity* is any action involved with handling or using a record. This includes retrieving, routing, copying (all or part), and reading a record:

   a. How many minutes does it take to create a record in this series?
   _____

   b. How many new records are created, on average, in a week? _____

   c. How many minutes does it take to index/annotate a new record? _____

   d. How many minutes does it take to file a record in this series? _____

   e. How many minutes does it take to locate and retrieve a record in this series?
   _____

   f. How many retrievals are made from this series in an average week?
   _____

   g. How many minutes does it take to duplicate a record from this series?
   _____

   h. How many copies are made of records in this series, on average, every week?
   _____

   i. How many minutes does it take to prepare a copy (or the original) of this record for transmittal? _____

   j. How many copies (or original records) are sent out in an average week?
   _____

k. How many hours per year do you spend performing periodic maintenance (inventory, audit, disposition, destruction, etc.) on this record series?

_____

4. What is the normal cycle time for a record from this series from retrieval to return? (Or disposal, in the case of copies)

1. Less than two minutes
2. Less than two hours
3. Less than a working day (8 hours)
4. Less than two working days (16 hours)

5. In an emergency, how fast would you need to retrieve and deliver a record from this series?

1. Less than two minutes
2. Less than two hours
3. Less than a working day (8 hours)

6. What percentage of retrievals from this series are emergency requests? _____%

7. What is the level of risk for the series?

1. Very Low Risk: Secure, easily duplicated, and off-site backup; probability of less than 2 percent errors or lost records per year. (Enter "1" in the RSQ.)

2. Low Risk: Safe so far, with some backup; probability of less than 5 percent errors or lost records per year. (Enter "2.5" in the RSQ spreadsheet.)

3. Medium Risk: May be at risk, little duplication or backup; probability of less than 10 percent errors or lost records per year. (Enter "5" in the RSQ spreadsheet.)

4. High Risk: At risk, no backup; possibility of up to 20 percent errors or loss in a year. (Enter "10" in the RSQ spreadsheet.)

5. Very High Risk: At extreme risk, no backup; probability of error or loss rate in excess of 20 percent. (Enter "20" in the RSQ spreadsheet.)%

8. Average dollar cost to replace one complete record?

1. $

9. How much space does this series occupy in paper? _____ cubic feet

Thank you, that's all the information needed to calculate costs for this record series. Please proceed to the spreadsheet template to enter your data.

APPENDIX B: Metric Development Team

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Vita

Captain Fredrick W. Knaak III, was born June 2, 1961 in Baldwin Park, CA. He graduated with Honors from Patrick Henry High School, San Diego, CA in 1979. He earned an Associates of Arts degree (Major: General) from Grossmont College in 1981. In July, 1982, he married the former Patricia Marie Huizinga in San Diego, CA. He entered the USAF in September 1983. He served as a Signals Intelligence Analyst at Wheeler AFB, HI, from 1984 until 1987. He served as a Communications-Computer Systems Operator at Minot AFB, ND from 1987 until 1991.

Capt Knaak was awarded a Bachelor of Science degree (Major: Business Administration) from the Regent's College, University of New York, in June 1990. He attended Officer's Training School and was commissioned in June 1991. His first assignment as a commissioned officer was to Goodfellow AFB, TX, as the Headquarters Squadron Section Commander and the Military Training Flight Commander, 315th TTG. Captain Knaak served another overseas tour at Kleine Brogel AB, BE, from 1992 until 1995 as the Support Flight Commander/Emergency Actions Officer.

In May 1995, Captain Knaak entered the Air Force Institute of Technology's School of Logistics and Acquisition Management at Wright-Patterson AFB, OH, to pursue a Master of Science Degree in Information Resource Management. Upon graduation from AFIT, Capt Knaak will be assigned to the 37th CS, Lackland AFB, TX, as the Information Systems Flight Commander.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 1996	Master's Thesis

4. TITLE AND SUBTITLE
AUTOMATED DOCUMENT CONVERSION:
A MANAGER'S PERSPECTIVE

5. FUNDING NUMBERS

6. AUTHOR(S)
Fredrick W. Knaak III, Captain, USAF

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
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AFIT/GIR/LAS/96D-4

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Olthea Croom
USAF/SCMI
1250 Air Force Pentagon
Washington, DC 20330-1250

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
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12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 Words)*

Technological advances in our workplaces have made electronic documents pervasive throughout the USAF, DoD, and civilian world. Managers are recognizing the need to establish electronic document management systems to handle these diverse forms of documents. Unfortunately, they have been faced with essentially "reinventing the wheel," when it comes to determining which types of paper-based documents are best suited to conversion to an electronic format. There is also a lack of clearly identifiable cost factors associated with automated document conversion (ADC) for managers to use when conducting an economic analysis of a potential imaging application.

This thesis addresses the problem of developing a practical solution to identify cost and mission effective ADC applications, and the primary cost factors associated with ADC, both tangible and intangible. While the researcher offers no statistically significant findings, valuable information is presented which helps managers identify ADC applications which will provide the most mission impact for their precious resources. It also provides an understanding of the tangible and intangible benefits of an ADC project, as identified by experts in the document imaging field. Additional "lessons learned" are related by the experts which provides information valuable to managers considering this technology for solving their own business problems.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Records Management, Information Management, Cost Effectiveness, Information Sciences, Conversion, Costs	132
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

AFIT Control Number AFIT/GIR/LAS/96D-4

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